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CHARLES H. SMITH
EDITOR
Hyde Park High School, Chicago

CHARLES M. TURTON
BUSINESS MAVAGER
Bowen High School, Chicago

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THE BIG TREE OF TULE

BY CHARLES J. CHAMBERLAIN,

University of Chicago.

Most of us have a natural interest in things which are very old or very large. A spear point, imbedded in the bone of an animal which became extinct thousands of years before the beginning of historical records, makes us wonder what kind of a man threw the spear. The walls of Babylon impress us with their immense size. But some plants are very old and also very large. How old and how large? The size can be measured but a determination of the age may be difficult and, in many cases, uncertain.

Some more or less popular accounts claim that there are brown algae, kelps, of the Pacific Ocean, which reach a length of more than 1,000 feet. Oltmanns, a competent algologist, but who never visited our Pacific coast, shortens these kelps to about 600 feet; and competent botanists, studying the big brown sea weeds from Alaska to San Diego, and making exact measurements, have continued the shortening process, until it is certain that the longest plants are not to be found in the ocean.

It has been claimed that some Australian trees, of the genus *Eucalyptus*, reach a height of 450 feet, with a diameter of sixteen feet. If the claim is well founded, these are the tallest living organisms in the world, and taller than any of the extinct plants of geological ages; for, while some of the Paleozoic lycopods were immensely larger than any living representatives of that phylum, none of the tree forms of by-gone ages reached a height of much more than 100 feet. The monster vertebrates of the Mesozoic did not wander around among monster trees.

The Kauri (*Agathis australis*) of New Zealand should always be mentioned in any account of big trees. This magnificent

tree sometimes reaches a height of 150 feet, with a diameter of ten to fifteen feet; its smooth cylindrical trunk, scarcely tapering at all, rising fifty to eighty feet before it begins to branch. In spite of those practical people who see only the splendid timber, hard and strong as oak and clear as the highest grade of white pine, the government has been able to establish extensive reservations, so that there is no danger that the Kauri forests will become extinct.

The Sequias of California are so well known that they need only to be mentioned. They may reach more than 300 feet in height and a diameter of 36 feet has been recorded. They are the largest of living organisms and the National Geographic Magazine publishes a widely distributed picture with the caption, THE OLDEST LIVING THING.

The Big Tree of Tule, less widely known because it is off the beaten track of tourists, deserves a place among the big trees because its trunk has the greatest diameter and it, rather than the *Sequoia*, may be the oldest living thing in the world. It is a Cypress, *Taxodium mucronatum*, commonly known as the Montezuma Cypress, and so closely related to the Swamp or Bald Cypress, *Taxodium distichum* of the southern United States, that some botanists do not give it specific rank, but call it *Taxodium distichum*, var mucronatum.

It stands in the little churchyard of Santa Maria del Tule, about 250 miles southeast of the City of Mexico. More majestic proportions would be hard to imagine, for the trunk is fifty feet in diameter and a regiment of soldiers could rest in its shade. Twenty-eight people, with outstretched arms and with finger tips touching, can just reach around the trunk. The diameter is fourteen feet more than that of the largest of the Sequoias, but the height is only 150 feet. The tree is massive rather than tall (Figure 1).

Some have suggested that this is not a single tree, but a group of trees grown together, I examined the tree quite carefully but could find no evidence in favor of such a theory. In general appearance, it is beautifully symmetrical, as can be seen from the figure; and the branching seems to show conclusively that this is a single tree. It is simply a giant among its kind, just as there are giants among men. The names of Hercules, Samson and Goliath may sound mythical but, doubtless, gigantic men and tales of their exploits gave rise to whatever is mythical. Even now, an exact scientific account of the Big Tree—to those

who have not seen it—might sound exaggerated or even mythical.

When I visited the tree in 1908, there was not a dead twig in sight. The foliage has the same beautiful, feathery appearance as in our Swamp Cypress, but, unlike the Swamp Cypress, which sheds its leaves every Autumn, the Big Tree of Tule is

THE BIG TREE OF TULE, A FEW MILES SOUTH OF THE CITY OF OAXACA. Diameter of trunk, 50 feet; age about 5,000 years.

evergreen. This does not necessarily exclude close relationship between the two, for it will be remembered that many trees which are deciduous in our northern states, become evergreen in the south.

The Montezuma Cypress was abundant in the Valley of Mexico when Columbus discovered America. At that time, the city of Mexico was an American Venice, with canals for streets, and it was customary for rich Aztecs to have floating artificial islands with little cottages on them, which could be poled around on the neighboring lakes; but the Spaniards drained the lakes and the big Cypress trees disappeared. In the city of Mexico a single historic specimen, the *Arbol del Noche Triste* (tree of the Sorrowful Night), under which Cortez rested after his disastrous defeat, still stands, protected from tourists by an iron fence. The Montezuma Cypress is still found along rivers, but specimens are comparatively small, not surpassing the Swamp Cypress of our southern states.

How old is the Big Tree of Tule? The age of a tree is determined, as far as it can be determined at all, by counting the annual rings. A piece of trunk of a specimen less than five feet in diameter showed about 200 rings on a radius of twelve inches. The counting is difficult and not altogether certain, because the rings are close together and often indefinite. If the rings of the Big Tree have about the same width as in this sample, the age cannot be less than 5,000 years; for it is well known that the largest rings are near the center and rings become smaller and smaller as a tree grows older. Some of the California Sequoias have reached an age of 4,000 years, but the Big Tree of Tule is at least a thousand years older.

More than a hundred years ago, Humboldt, the great traveler, visited the Big Tree and, on the east side of it, carved an inscription, now partly overgrown, so that the beginning and end of each line has been covered by wound tissue. The development of this tissue indicates that the tree is growing very slowly, so that the annual rings must be much smaller than those formed a couple of thousand years ago.

Resting under the shade of the Big Tree and remembering its great age, one could hardly avoid thinking of events which have occurred during its lifetime. Before the Pyramids of Egypt were built, it was a sturdy tree; and before Moses led the children of Israel out of the wilderness, it must have reached the usual size of the species; when Rome was founded, it must have been known as a big tree; in the days of King Arthur and his table round, its reputation as a giant among its kind must have been established; and ever since there have been Mexican traditions, Indians have made pious pilgrimages to the Big

Tree of Tule. It must have been a familiar object to the prehistoric men who built the Pyramids on the near-by Monte Alban, and who erected the wonderful buildings now known as the Ruins of Mitla.

Such an exceptional tree ought to be preserved. It is not in much danger from natives, because they regard it with veneration; and the fact that it stands in a churchyard is an added protection. But still more effective, as far as travelers and tourists are concerned, is the wise foresight of the government which, remembering the vandal propensity of tourists, stationed such efficient guards at the tree, that John Doe, Chicago, and John Smith, New York, have not been able to disfigure the trunk by carving their names upon it. Let us hope that during the recent unsettled conditions, Mexico has continued to safeguard the Big Tree of Tule.

TEMPERING COPPER BY THE ANCIENTS.

The general belief that the ancients were able to harden or temper copper to a greater extent than is now possible is a myth, in the opinion of the United States Geological Survey, Department of the Interior. It is well known to metallurgists that processes of rolling will harden copper to some extent and that it can also be hardened by the addition of other metals. Specimens of ancient so-called "tempered" copper that have been examined have invariably proved to be no harder than copper that is manufactured to-day, or to be simply an alloy of copper and some other metal.

KINDS OF CHEMISTRY.

Professor David Sneeden, discussing the subject, "Desirable Aims of School and College Chemistry," contended that the time is ripe for differentiating two radically unlike types of courses, certainly in secondary schools, and probably in colleges.

The first type of course should have as its primary purpose culture in the sense of interests and appreciations. It should be designed primarily for those who will probably not encounter needs of giving appreciation to chemical knowledge and technique except as utilizers.

The second type of course should be for those who expect later on to apply in some sort of productive process their chemical knowledge and training in process. Courses of this character should, manifestly, be rigorous, exacting, and systematic.

But courses of the first type should be essentially *liberal*—that is, *liberating*. They should culminate in wide and varied appreciations, insights, vital interests. The methods of instruction and training should assuredly not be rigorous and exacting in a sense appropriate to the other type of course. But liberal education here should not be confused, as it often is, with superficial, sloppy education. There are fine standards of amateur execution and appreciation, no less certainly than there are fine standards of professional performance.

Once differentiate the two types of courses here suggested, it seems probable that the teaching of science will take on a new vitality.

RESULTS WITH STANDARD CHEMISTRY TESTS.

By B. J. Rivett,

Northwestern High School, Detroit.

About three years ago the writer became interested in the problem of devising short time chemistry tests. The chief aims of these were to determine quickly the pupils' knowledge of important topics in chemistry and to save the hours of time required to grade the long written tests. This study led to the attempt to devise some standard tests, by which is meant tests that will be given under the same conditions and be scored the same by any teacher or pupil. It was not considered wise to try to cover the whole field of chemistry, but rather to test some fundamental facts which every pupil should learn in elementary chemistry. A pupil can not progress very far in chemistry without a knowledge of the symbols of the common elements, the valence of the most important elements and radicals, and the ability to write formulas of the most common compounds. Therefore, three time tests were devised and given to the chemistry pupils at Northwestern High School, namely, a test of writing the symbols of thirty-one important elements, one of twenty valences, and one of twenty formulas. The time allowed for each test was carefully determined by giving it to a number of classes and ascertaining the time required by the majority of the pupils. When this preliminary work had been completed and the tests given to pupils in several high schools, the educational research department examined the tests and suggested several improvements in their arrangement and the method of scoring.

Nature of the Tests.

At this point it may be well to explain in some detail the nature of the tests, the method of giving them, and the score sheet. Test Number 1, or the test on symbols, contains the names of thirty-one elements with a blank space for the symbols. These are arranged in the order of their difficulty, as determined by giving the test to a large number of pupils. Test Number 2 contains the names of twenty important elements and radicals with the direction that the pupil is to write the valence in a binary compound of each. Test Number 3 contains the names of twenty common chemical compounds, such as sodium chloride and ammonium hydroxide, arranged in order of their difficulty with the direction that the pupil is to write as many formulas as he can in the time allowed.

Directions for Giving Tests.

The tests are given in the following manner:

(1) The printed tests are distributed to the pupils by placing the papers face-down on their desks.

(2) The pupils are told to be ready for the signal to start.

(3) When this signal is given each pupil turns the paper over and writes until the time is up and the teacher says "Stop!" The time for the symbol test is one minute and thirty seconds.

(4) The pupils exchange papers and the teacher reads the correct answers. The pupils mark each answer "C" for correct and "X" for incorrect, as the case may be. The number of correct answers is recorded on the paper and then it is returned to the owner. Finally the papers are collected by the teacher who calculates the score for the class.

The Score Sheet.

The score sheet can be best understood by referring to the one below.

	Formulas	Number	Per Cent.	Points
Group I	20	12	14.5×10	145
Group II	19, 18, 17	28	31.5×9	283.5
Group III	16, 15, 14, 13, 12	26	28.25×7	197.75
Group IV	11, 10, 9, 8, 7	16	18.5×4	74
Group V	6 to 0	6	7.25×0	0
Total				700.25

The score is on a 1000-point scale, that is, if all pupils had written the twenty formulas correctly by the total score for the class would be 100x10 or 1000. It will be observed that 88 pupils took this test, of which 12 were in the first group, that is, those who wrote twenty correctly. The number of points obtained by this group was obtained by the per cent of 12 divided by 88 or 14.5 multiplied by 10, which is 145. The second group contains those who wrote 19, 18, and 17 correctly and the number of points is obtained by multiplying the per cent of 28 divided by 88 or 31.5 multiplied by 9, which is 283.5. The points for the other three groups are obtained as shown on the score sheet.

The symbol, valence, and formula tests were given to the

pupils in elementary chemistry of all Detroit high schools in January, 1921. The results are in terms of a possible 1000 points, and are shown in the following table:

DETROIT AVERAGE SCORES IN CHEMISTRY TESTS.

Course I	No. Pupils	Point Scores
Test 1—Elements	869	764
Test 2—Valences	786	530
Test 3—Formulas	850	533
Course 2	No. Pupils	Point Scores
Test 1—Elements	538	854
Test 2—Valences	538	610
Test 3—Formulas	539	760

The data indicate that at the end of the first semester the average pupil in the city has acquired approximately 76 per cent of the possible score in the elements test, and about 53 per cent in both valence and formula tests. By the end of the second semester's work the score in the elements test is 854 points or 85.4 per cent of the total possible score. In the test on valence about 61 per cent of the possible score has been achieved, and 76 per cent in the test on formulas.

The same tests were repeated in all Detroit high schools in June, 1921, and the results are shown in the following table:

DETROIT AVERAGE SCORES IN CHEMISTRY TESTS.

Course 1	No. Pupils	Point Scores
Test 1—Elements	667	878
Test 2—Valences	680	600
Test 3—Formulas	685	647
Course 2		
Test 1—Elements	697	917
Test 2—Valences	717	797
Test 3—Formulas	715	874

The data may be interpreted in the same manner as described for the results in January, 1921. A comparison of the scores for the two semesters indicates that there is a marked increase in the scores on all tests the second time they were given. These increases varied from 6 per cent in Course 2 on elements to 19 per cent in Course 2 on valences. Undoubtedly, the reason for this is that more drill was given the second semester on the writing of elements, valences, and formulas.

Now there are some tentative standards by which one pupil may be compared with another, one class with another in the same school, and a school with the average for the city. The same tests in a varied form will be repeated this year, and other tests on fundamental topics will be tried with the hope that eventually standard tests covering all the minimum essentials may be used.

A METHOD OF TEACHING BACTERIOLOGY IN A BIOLOGY COURSE.

By Helen Kerr Maxham,

University of Oregon High School, Eugene, Oregon.

Teachers who take up the work of general science or civic biology for the first time soon find themselves fairly aghast at the number and variety of "ologies" and otherwise with which they must needs have more than a bowing acquaintance, and to such as are out of reach of libraries which can furnish helpful reference work, or have not some friend at hand well-versed in the particular strange "ology" to be presented, a slight record of what was recently done by a band of explorers at the University of Oregon High School may be of interest.

Bacteriology was the unexplored country, and the teacher thought as she looked across the holiday vacation into its mysterious reaches, that, though there might not be giants in that land, there were problems for her equally fearsome.

The class was large, over thirty pupils, one hundred per cent alive, and having a wide range of preparation as well as of ability, so that no uniform assignment could be given, neither was actual laboratory work possible for all, and, as I have intimated, the teacher herself had no training in the subject.

Discipline was difficult in such a group, as was also the problem of keeping everyone working at full efficiency, but it was decided to capitalize these problems. For the half dozen most advanced pupils, who were in second year high school, she arranged special assignments, the work on which would occupy much of the month to be devoted to this particular phase of biology.

During the holiday vacation the reference works on this subject to be found in the University library were examined, and some few found which could be used by this group of "specials." Abbott, "Principles of Bacteriology," and Frost, "Laboratory Bacteriology," were found especially helpful for reference, while for her own use, Moore, "Laboratory Directions for Beginners in Bacteriology," was most illuminating and convenient as well.

At the first meeting of the class after vacation the special assignments were given out in the form of problems, and the pupils told that upon the work of this assignment would depend their grade for the month.

Each problem was in writing and was made sufficiently explicit, and the directions for procedure sufficiently definite so that

there was little or no need for further explanation. The group was dismissed at once to go to the University library, situated within the block, for work on the initial stages of their problems.

This left a more homogeneous group to deal with in class, and automatically solved much of the problem of discipline for the time. The remainder of the period was given over to a discussion of the general characteristics of bacteria and of their economic importance.

The specials reported at the *end* of each class period unless otherwise directed, in order that they might not abuse their liberty and fail to report promptly for the class following biology.

All were required to prepare an outline in writing showing in detail:

(a) Method of preparing beef bouillon and nutrient agar-agar for the culture of bacteria
(b) Sterilization of glassware
(c) Tubing of media
(d) Sterilization of media in tubes
(e) Methods of obtaining and cultivating bacterial colonies
(f) Of innoculating tubes of nutrient agar
(g) Of pouring agar plates

The individual problems were such as deal with everyday circumstances in the lives of the pupils. One culture was made by moistening the hand, scraping it with a sterilized scalpel, then inoculating a tube of bouillon with this, and from the culture developing in it, growing colonies in a petri dish.

Another was from an old coin, another from scraping about the base of the teeth with a flamed scalpel *before* brushing the teeth, and still another was made by placing a hair from a pupil's head *before shampoo* in a tube of bouillon.

Quite the most conspicuous bacterial colonies came from the dirt from the pupil's hand. They spread rapidly in a silvery, lichen-like growth, and excited much interest in all the members of the class.

Special reports upon the preparation of media were presented to the class on Wednesday and Thursday. All were required to take note of these, the important features were discussed, and points not clearly understood were explained. On Friday morning three of the specials demonstrated the preparation of beef boullion at the laboratory table before the class. The laboratory is equipped with gas for experiments requiring heat, with running water both hot and cold, with balances, and with a fair supply of glassware, but has no special equipment for bacteriology, so certain necessary pieces of apparatus were evolved from materials at hand.

An old rice-cooker, having an inner compartment of aluminum and still in good condition was brought by the teacher for use in preparing the media, and two Bunsen burners under it furnished sufficient heat to bring the water in it quickly to a boil.

As the preparation of extract from fresh beef involves more time than the class could well afford, Liebig's beef extract was used instead. The extract, peptone and salt required were each carefully weighed and then dissolved in a beaker in a part of the five hundred cc. of water which had been measured into the cooking utensil: all was brought to a boil and the boiling continued in a covered dish for about twenty minutes, when the preparation was ready to be tubed.

Since there was not time in that period for further work the bouillon was poured into a sterilized fruit jar and sealed for use on the followin Monday, when it was reheated and poured into test tubes. These tubes had been well cleansed first with soap powder, hot water, and a brush, then boiled for several minutes in clear water to make sure that they were surgically clean.

About ten cc. of bouillon was poured into each tube, the tubes carefully stoppered with cotton batting, placed in a wire test tube basket, and sterilized. Through the kindness of the Bacteriology Department of the University this sterilization was done in their laboratory autoclave, but the same results may be obtained by using an ordinary kettle and colander or perforated pan which fits closely into the kettle top and will hold the test tubes or other material to be sterilized.

Since the heating in the autoclave is under fifteen pounds of steam pressure, sterilization is completed in much less time than can be done otherwise, but by steaming for an hour in an improvised sterilizer such as the one suggested, all bacteria will be destroyed. To make sure of the destruction of spores which may be present it is well to repeat the steaming operation on two or three successive days, making sure that the water in the bottom compartment is actually boiling for fully twenty minutes each time, and that the steamer part is closely covered.

Empty glassware, such as petri dishes, flasks, etc., may be sterilized by heating in an ordinary range oven at 170 degrees C. for one hour, allowing the oven to cool down to a point where there will be no danger of breakage of the glass from drafts of cold air before opening the oven.

At the class period following the sterilization of the boullion

tubes each of the specials took two test tubes and inoculated them: some with *before* and *after* tests, as for example, before brushing the teeth, and after brushing with a dentifrice. The tubes were set aside in the laboratory locker for a few days of incubation, but as the weather chanced to be quite cold they did not show activity during that week, so were taken home by the teacher and kept in a living room where the temperature was kept nearly equal both night and day. By the sixth day following inoculation there was noticeable cloudiness in the culture from an old coin, so two agar tubes were inoculated with this and agar plates poured

As evidence of bacterial action became pronounced in other tubes agar plates were made from those cultures, but on account of lack of heat the latter ones did not become well developed in the time allotted to this study

It seems to the writer that an incubator might be improvised somewhat on the order of a homemade fireless cooker, by padding the inside of a box well with some substance of low conductivity, and using a heated soapstone to supply the heat necessary for rapid incubation.

The nutrient agar was prepared by those of the specials who had not taken part in preparing the boullion, its preparation being demonstrated before the class, explained by the teacher, and reason for the use of the different ingredients, as well as for the successive steps in its preparation discussed and explained.

Each member of the class was required to write out this problem, methods and materials, observations, and conclusion, and was held responsible for knowing just how to do the work. This, of course, does not take the place of actually doing the work one's self, but where individual laboratory work is out of the question it serves as a helpful substitute.

Directions for the preparation of both beef boullion and nutrient agar may be found in laboratory manuals or texts on bacteriology, but the straining of agar through filter paper as recommended by them is such a long and tedious process that workers in this field will be glad to know of a process recommended by Prof. A. R. Sweetser, head of the Bacteriology work in the University of Oregon.

A handful of excelsior is placed in the funnel to be used. Over this is spread a layer of cotton batting to extend out onto the sides of the funnel. The straining apparatus is placed in the steam bath, the boiling agar poured upon the cotton, and—

Presto! The thing is done! Only those who have used filter paper and an improvised steam bath can fully appreciate the difference.

The agar is tubed while hot, sterilized, and part of the tubes laid in a slanting position to cool for the preparation of slant agar, while other tubes are left upright for "stick" or "stab" cultures.

One phase of work taken up while studying bacteria was life sketches of men who have contributed largely to building up the science of biology. The pioneer work of Jenner in vaccination for smallpox; the importance of Liebig's work in Organic Chemistry as bearing upon experimental bacteriology; the contributions of Koch; and the revolutionary effect of Darwin's discoveries and the theories which grew naturally from them. All these as well as several others which were taken up, proved intensely interesting, but for real, thrilling romance, Pasteur was easily in the lead.

Most of the materials for these life sketches were taken from "Biology and Its Makers," W. H. Locy, although some excellent ones came from other sources, and one or two from "Science" or "The Science Monthly," which can scarcely be called milk for babes, but such was the interest and enthusiasm aroused in this study that it was with real regret that the pupils left it before more fully covering the ground.

For the study of Pasteur's life, "Pasteur, The History of a Mind," Duclaux, and "Life of Pasteur," Vallery Radot, are highly recommended for the teacher's reading, but are somewhat beyond the grasp of most high school pupils.

Looking back over the month's work, there are mistakes to be noted, omissions of important points that might have been covered, and some work not completed because we did not know in time to profit by the knowledge of how to overcome certain difficulties. Viewed as a whole it stands out as a month of enthusiastic endeavor, of real progress, and of inspiration for further work in the same field.

ENORMOUS RESERVES OF LIGNITE IN ALASKA.

The reserves of lignite in the Nenana region, Alaska, are estimated by the United States Geological Survey to be nearly 10,000,000,000 tons, which exceeds by nearly 3,000,000,000 tons the estimate made a few years ago, on the information then available, of the total quantity of lignitic coal in the territory. The new estimates, which are very moderate, indicate that the quantity of coal available in the Nenana coal field is greater than that in all the other surveyed fields of the territory.

A FEW LIVE PROJECTS IN HEAT AND SOUND

By Frank M. Rich,
Principal School 19, Paterson, N. J.

A famous cartoon of Benjamin Franklin shows a serpent cut into sections, labelled with the names of the colonies and headed with the caption "Unite or Die." Substitute for the colonies the names of the studies in the curriculum and you have a fair picture of the situation in education. In its present condition it is not a very lively creature. Each section squirms along in its own direction, more or less indifferent to the wriggling of the others. Much effort is expended, but corresponding progress is not attained. Does it not seem reasonable to suppose the pieces would all work better if they all worked together? In other words, would not a close correlation among subjects, if feasible, result in a great increase in efficiency, economy and interest?

It must be admitted that in the highly artificial organization of subject matter, customary in departmentalized instruction, correlation has been difficult. There is naturally a good deal of skepticism concerning it. Where it must be dragged in by the tail merely to satisfy some hair-splitting pedagogical sophistry, it does not commend itself.

But perhaps the great difficulty in effecting practical correlation has been that of trying to put new wine into old skins. The cut-up serpent is hard to reassemble, hence the need of a new one, all in one piece. When the work is laid out, not by subjects but by projects, correlation takes better care of itself. It becomes a natural and economical feature of the work. There is no need to strain at gnats of pedagogy, and swallow camels of wasted time in order to bring related subjects together. In the departmentalized instruction there is a temptation for the manual training teacher to balk at having to spend much work on the mathematics of his problem. The mathematics teacher cannot pause in the manipulation of formulas to go into the intricacies of science. The science teacher hasn't time to show students how to do a neat, practical piece of construction; and so they pass the buck along. A good many big, meaningful experiences are consequently lost in the shift, and a good deal of empty formality substituted instead. It may be a long time, perhaps, before all high school instruction can be organized on a project basis, and before all projects can be sifted to secure the optimum returns. But eventually the thing will be done;

and in the meantime, the radicals and progressives, who are fortunate enough to be able to use a little of their own initiative without fatally outraging their more conservative patrons, can give a good deal of inspiration to their students and extract considerable comfort for themselves in helping the cause along a little at a time as opportunity offers. "Anything is *true* that can be made to *work*."

The projects described here may be classified as physics, or mathematics, or amateur metal work, or scout-craft, or just a little fun, as you please. If one cares to undertake correspondence and exchange of products between students of the same or other schools, it is possible to motivate composition, drawing and good fellowship. There is a growing field of book and magazine literature also that can be brought in, without too much strain, perhaps, on the readers' belief in correlation, motivation and socialization. My experience with the projects in a small way has been that they contain enough inherent interest to hold the average eighth to tenth grade boy, and a certain type of girl of the same age, through some pretty stiff research, calculation and experiment. The projects here described are a cylinder engine and talking machine, all made of discarded tin cans.

It is not to be expected that everybody in a class can build all the machines described, or even one of them, but the instructor can always interest some ingenious spirits, who will enjoy working out models in advance and then explaining them to the remainder of the students. They in turn will be interested in taking notes, and making drawings and computations for future reference, and in building the machines as opportunity permits.

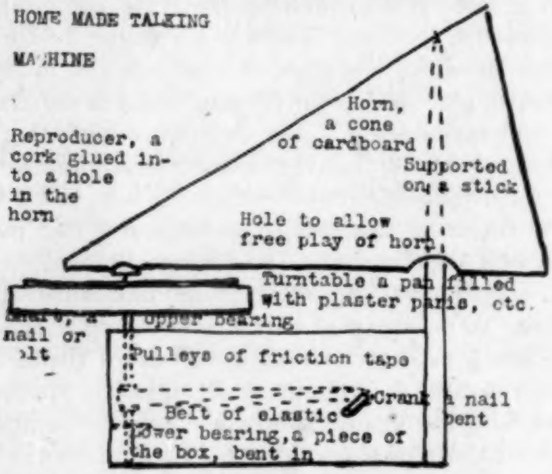
Soldering.

The use of tin in these machines necessitates learning to do a little work in soldering, but this is easily managed. The public library will furnish some book giving detailed directions.

1. The "iron" must be well "tinned" or coated with solder before operations begin. To "tin" the "iron," file the flat surfaces perfectly smooth and bright. Heat the "iron" in smokeless white coals or blue flame of gas, alcohol, or gasoline stove. Remove it when the fire burns green, but before the iron has begun to glow. Rub it into solder placed on a board or sandpaper, at the same time applying a flux made of hydrochloric acid with as much zinc as possible dissolved in it, or what is not quite so good, sal-ammoniac or rosin.

2. All surfaces to be soldered must be filed, scraped, or sandpapered spotlessly bright and clean or the solder will not stick. The flux helps to unite solder and metal by preventing the oxides from forming between them.

3. Hold the work and apply the heat to solder and article so that the solder will run down into the seam, and unite broad surfaces together firmly, not merely tacking them across with a flimsy strap or hinge of solder. In some difficult cases, especially when soldering something to a wire, it is well to coat the pieces separately with solder, and see that it sticks well; then joining the two easily by running a little solder in between.



THE TIN TALKING MACHINE.

The building and operation of the home-made talking machine gives the student an almost instinctive appreciation of the laws of sound. The nature of sound, of quality of tone, of pitch as related to speed of vibration and the principle of resonance are well illustrated. The problem of proportioning pulleys so as to get the correct reproduction speed involves simple, but useful, calculations in shop mathematics. If the maker wishes to substitute careful calculation instead of rough approximation in constructing the model there is use for a number of simple problems in elementary geometry, triogonometry and the measurement of circles. The practice afforded in drawing and description is apparent.

The materials needed for the talking machine are a rectangular tin box or an empty oil or varnish can, for a body (10 inches is a good length); a pie tin, pail cover or large circular can cut down,

for a turntable (10 inches for large and less for toy records); two large nails, heavy wires, or long thin stove bolts, for shafts; a little friction tape (electricians', baseball or bicycle tape) for pulleys; elastic webbing (garter elastic) for a belt; a sound cork or wooden plug for reproducer; a strip of light wood for horn support; a square of cardboard for a horn; and, of course, disk records and needles.

If a covered box is used for the body, nail the cover to the horn support. At the opposite end measure evenly with dividers, and bore holes for bearings for the turntable shaft. With a knife, cut around the lower hole on three sides, and bend a flap of tin inward in such a way that the bearings are in line to hold the shaft vertical. The shaft's lower end rests on the bottom of the can.

Bore a hole in the center of the turntable, and solder to the shaft so that it will spin a half inch or so above the box. The end of the shaft should project slightly above the turntable, and hold the record in place. If necessary, file or cut the head of the nail so that it will pass through the hole in the record.

Center with dividers and bore hole for crank shaft. Push the shaft through from the back, and bend a small crank on the front, close enough to the box to prevent much play. All bearing holes should be a good fit for the shafts, to avoid either binding or rattling. Put on the belt so that the turntable will turn clockwise with a clockwise motion of the crank. Fasten the belt with a tiny safety or other pin put in crosswise, parallel with the shafts. See where the belt runs when the shafts are in motion, and put on pulleys consisting of a few turns of tape. Dust the outside of the pulleys to take off too much stickiness on the tape.

Cut a quarter circle of cardboard. Soak and bend into a cone. Apply glue on the seam and tack to a stick to dry. Cut a hole for the cork or wooden reproducer in the side of the cone opposite the seam and an inch or two from the point. After the reproducer has been bored with a small hole for the needle, which sinks well in with a good tight fit, at an angle of 45°, pointing in the direction the record turns, glue firmly in place.

The lower side of the horn is horizontal; the upper rests on the top of the wooden support, and is held loosely in place with a brad. The support passes through a large hole in the under side of the horn and hangs loosely enough to allow plenty of play.

Fill the turntable pan with plaster paris, cement, tar, or other

heavy substance; see that the surface is perfectly flat, and set in a level place to harden. Cover the turntable with a disk of blotting paper. Put on the record; adjust the needle in the groove; turn the handle, and you will be surprised at the power and clearness of the reproduction.

Problems in Construction of Talking Machine.

How locate the center line for holes for the turntable shaft, using the dividers?

How use the dividers to locate holes for crank shaft?

How use the dividers to determine where the flap of tin that constitutes the lower turntable bearing should be bent?

What is the diameter of a horn made from a 15-inch square of cardboard?

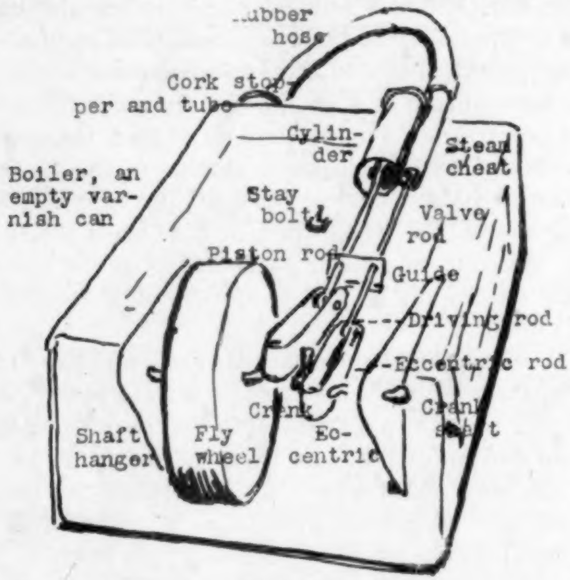
What angle has the profile of this horn?

Where will the horn support have to be placed so that the needle always travels as nearly as possible from the front toward the center of the record?

When the distance from the needle to the center of the horn support is known, and the angle of the horn's profile, how can we locate the hole for the brad in the upper side of the horn? Use trigonometrical tables or squared paper.

How large should the hole in the under side of the horn be made to allow the needle two inches play?

To run the machine steadily, it is convenient to turn the crank by a watch, one turn per second. What should be the proportional diameter of the pulleys to give the turntable a speed of 78 turns per minute?



TIN CAN ENGINE MODEL

The Tin Can Steam Engine.

The tin can steam engine brings out very well the essential parts and workings of the ordinary cylinder engine: The ques-

tions that naturally arise: How much power does the engine develop? and how much pressure can be safely applied? lead to interesting and useful calculations of power and the strength of materials.

The materials needed are an empty one gallon varnish can for a boiler; a large, sound cork stopper; a bit of flexible gas tubing of rubber or metal; a little smooth tin or copper tubing the size of a lead pencil for steam chest and connections; a small tin box—say a shaving soap box—for a cylinder; some heavy tin or galvanized sheet iron for shaft hangers; guides, connecting rod, eccentric rod, piston and valve heads, two or three feet of stout wire for piston rod, valve rod, and crank shaft; a flat head stove bolt, preferably galvanized, for stay bolt; and two round cans, 6-8 inches in diameter and cut down to 1-2 inch deep, one fitting neatly inside the other for the flywheel.

In the crankshaft bend two cranks, an inch deep, and at an angle of 90° to each other. Make them close together and as broad as the diameter of the cylinder and steamchest will allow. Have the elbows in the cranks as square as possible, the treads parallel with the shaft and the ends of the shaft in perfect alignment.

Make a hole in the exact center of the larger can and solder on the crank shaft, close to the crank. Coax it and nurse it, this way and that till the rim runs true. Then fill the can with soft plaster paris, cement or other filler; bore the small tin and press carefully into place, and let it harden, making the flywheel complete.

Cut the strips of metal that make the connecting and the eccentric rods. When doubled they should be a little longer than the radius of the flywheel. Bore the two holes in each near the center, just large enough to slip over the elbows of the cranks, and in the ends, holes to fit the rivets that connect them to the piston and valve rods. Where the valve rod joins the eccentric rod it is well to make a series of rivet holes close together, so as to permit a certain amount of adjustment in the location of the sliding valve.

Make pasteboard patterns and, when they are right, cut shaft hangers so proportioned that the crank shaft will be on a level with the center of the cylinder, and the rim of the flywheel not too far from the boiler for stability. Bend flanges where hangers join the boiler and solder in place, the hangers being just inside

the ends of the crank shaft. Slip on the connecting and the eccentric rod. Put the shaft into the hangers, and fasten in place with small tin washers soldered to the ends of the crank shaft.

Bore a hole in the middle of the tube used for the steam chest. Bore another of the same size in the side of the cylinder, close to the cylinder head. Double soft hemp or linen thread to make a thick cord, and pull this through both holes tightly so as to draw the steam chest close against the cylinder. Hold them carefully in place and "tack" with a bit of solder here and there. Then solder the two firmly together, so that there will be no leak where the holes join. The cord will keep the connestion open between steam chest and cylinder, and when the connection is made the cord can be pulled out, and any chance projections inside the steam chest smoothed up very carefully with a round file. The barrel of the steam chest must be perfectly smooth.

Solder the cylinder to the boiler, in line with the connecting rod, turning the steam chest up so that its center is on the same level as the center of the cylinder, and as nearly as possible in line with the eccentric rod.

Cut out and bore a guide for piston and eccentric rod that can be soldered to the boiler in such a way as to prevent these rods from swerving out of line with the center of the cylinders.

Mark and cut out two disks, a loose fit for the cylinder, and two for the steam chest. Bore holes in the center to fit rods and solder so as to make a kind of spool for both piston and sliding valve. The sliding valve should not be much longer than the hole that connects the steam chest with the cylinder. Smooth all sharpnesses and imperfections from the disks with care. Wind the spools with soft linen or jute string till they are a perfect fit for steam chest and cylinder. While winding, saturate string with vaseline, axle grease or other heavy lubricant. Finish the end of the spool with a series of Blackwall hitches to prevent unwinding.

Determine the proper length for piston rod. Cut it off. Put the end through the guide and turn a ring for the rivet which attaches it to the driving rod. Tiny bolts cut the right length and provided with two nuts, one set against the other, have advantages over rivets. Do the same with the valve rod. If the cylinder is plenty long enough, the location of piston inside does not matter much, so long as the piston does not hit the cylinder

head at one end of the stroke, or allow steam to escape at the other end. But the location of the sliding valve is vital. This valve must cut the steam off from the passage into the cylinder just before the beginning of the back stroke, and pressing back into the inlet, allow the dead steam from the cylinder to escape into the open air; otherwise the engine will make but one half-stroke and stall. By having several rivet holes in the eccentric rod, as we have suggested above, the best one can be located by experiment.

Solder the guides in place. Make holes for the stay bolt, as near the center of the boiler top as possible. Screw the nut down to prevent the boiler from bulging, and solder thoroughly to prevent leaks. Bore the cork smoothly with small round file and fit in metal tube. Connect with the steam chest by slipping on rubber hose or soldering on flexible metal tube. Test the running of the engine by blowing into it. If everything is well oiled and in good adjustment the engine will start easily with a half-turn of the flywheel, turn a dozen revolutions to a breath, and run as long as the pressure continues.

When you have tested the engine out, partially fill it with water and set it on the stove. It will develop a speed that is quite startling. Look out for the cork stopper. This acts as the safety valve, but if it blows out when the hand is near the nozzle of the can, it may result in a painful burn. This engine, like any other, must be handled with good judgment. Steam is a willing servant but a bad master.

Problems Connected With the Tin Can Engine.

How can one determine the position of bearings in the shaft hanger with ruler and compass?

How make sure that the holes for the stay bolt are in the same vertical line?

How can one place the cylinder in exact line with the driving rod?

With cylinder and connecting rod in place, how can one calculate the length of the piston rod?

Same for the valve rod.

Knot string into the tube through the cork; attach a spring balance, and see what pressure it takes to pull out the cork. Calculate from the area of the cork what pressure per square inch would blow it out.

What is the tensile strength of boiler tin? Nail one end of a sample strip to a rafter and the other to a broom handle. Cut out notches from each side of the strip toward each other till the neck of metal finally tears under the steady weight of a boy of known weight. Measure the last width that successfully bore the weight. Reduce to tensile strength per inch.

Test sample across a seam as well as unbroken metal.

What pressure per square inch will the boiler stand? In general, the bursting stress upon any seam along a boiler is reckoned as twice the pressure on an area equal to a cross section of the boiler through that

seam. Allowing 1-6 of the tested strength as a safe load, what pressure per inch on largest surface will the longest seam support?

Suppose heat enough could be applied to maintain that pressure against a load at the rate of 100 revolutions per minute; what would be the power of the engine? The power expressed in foot-pounds per minute depends upon the area of the piston, the length of the stroke, the strokes per minute, and the pressure per square inch.

How much power does the engine actually develop with an ordinary gas flame? Rig up a prony brake, consisting of a well greased strap or cord passing round the flywheel, one end nailed to the end of a wooden lever, the other end attached to the side of the lever by means of a ring bolt and adjustable wing nut passing through a hole in the lever. Start the engine. Screw up the wing nut enough to slow the engine considerably. Measure the pressure exerted on a notch in the handle of the prony brake by means of a spring balance. Count the revolutions per minute. Calculate the circumference of a circle having a radius from the notch to the center of the flywheel. This distance in feet multiplied by the number of revolutions and the pressure gives the work done in foot-pounds.

FACTS ABOUT ASBESTOS.

The art of weaving the mineral fiber in asbestos, which is ordinarily indestructible, was rediscovered at a comparatively late period of civilization. Woven asbestos was used in the ancient pyre to preserve the royal ashes. Charlemagne is said to have had a tablecloth made of asbestos and to have cleaned it by throwing it into the fire, which consumed the dirt, thus illustrating, in a spectacular manner, one of the most valuable properties of this material.

The fiber of the best grade of asbestos is beautiful and silky and has great flexibility, elasticity, and tensile strength, according to the United States Geological Survey, Department of the Interior. It can be spun into thread so fine as to run 225 yards to the ounce, and as it is incombustible as well as a nonconductor of heat and electricity and resists the action of most ordinary acids, its field of use is large. The possible applications of asbestos are far from fully appreciated, not only by the general public but by manufacturers who are in search of material for special uses to which asbestos may well be applied. Perhaps it is most generally used to make fireproof cloth for theatre curtains. It has been used also for making firemen's clothing. Everywhere in cold countries it is extensively employed for covering furnaces, boilers, and pipes to prevent loss of heat. Asbestos is a good insulator.

FRAUD AND MINING VENTURES.

The United States Geological Survey, of the Department of the Interior, often finds that unscrupulous promoters of fraudulent mining schemes pretend to be connected with the Government service. Such a man who was recently operating in Colorado represented himself as one of "the eighty registered geologists in the Government service," but one of his intended victims found, on telegraphing to the Geological Survey at Washington, that he was not among its employes and that his name was not on the membership lists of either the American Institute of Mining Engineers, the Geological Society of America, the Association of Petroleum Geologists, or any other well-known geological society. Fraudulent practices of this sort should be reported to the proper state and federal authorities, and those who resort to them are liable to fine or imprisonment.

A SEASONAL BREAKAGE OF MAINSPRINGS IN WATCHES

By S. R. Williams,

Oberlin College, Oberlin, Ohio.

There seem to exist in every trade certain beliefs and notions, which are not always supported by scientific principles. It may be recalled that blacksmiths have an idea that if the red-hot end of an iron bar is suddenly plunged into water, while the other end is held in the hand, that the smith can notice a very rapid and perceptible increase in temperature of the portion held in his hand. In other words, they believe that the water very suddenly drives the heat from the hot end to the cooler one. Curiously enough, careful investigation of this idea was made by two departments of physics of leading universities of this country and quite independently could not find, by means of sensitive instruments, the changes which the blacksmiths seem to pretty generally recognize.

Again, there is a belief among many barbers that a thunder-shower dulls their razors and that special attention must be paid to sharpening them after the thunder and lightening.

These beliefs held by various trades should not be put in the same class with the superstitions held by many of our professional baseball players, as to the effectiveness of a rabbit's foot or some other talisman in bringing success to their playing.

It is well to remind ourselves that a blacksmith named Arstall, once conceived the idea that an iron rod would change its length, if magnetized. He spoke to Joule, a prominent physicist of England, about it, who became sufficiently interested in the suggestion to test it and found, indeed, that such was the case, although an extremely small increment of length occurred when the magnetic field was applied.

While the explanations offered by the trades for their ideas are not always supported by scientific reasons, there are fundamental principles back of them which show why they persist in the minds of those who believe in them. For instance, in the case of the iron rod whose heated end is suddenly plunged into cold water, in all probability steam arises from the water where the heated rod enters it and this steam ascending envelops the hand grasping the other end and gives the sensation of a sudden increase of temperature. At any rate the ideas are frequently worthy of further investigation as the following may well illustrate.

Enquiry among a number of those engaged in the business

of watch repairing reveals a persistent notion that the electricity present during a thunder shower is accountable for a large number of mainsprings snapping during and immediately following a thundershower. This would mean that a maximum number of mainsprings would be broken during the summer months. The practice of jewelers to record all replacements of mainsprings makes the study of a possible seasonal breakage

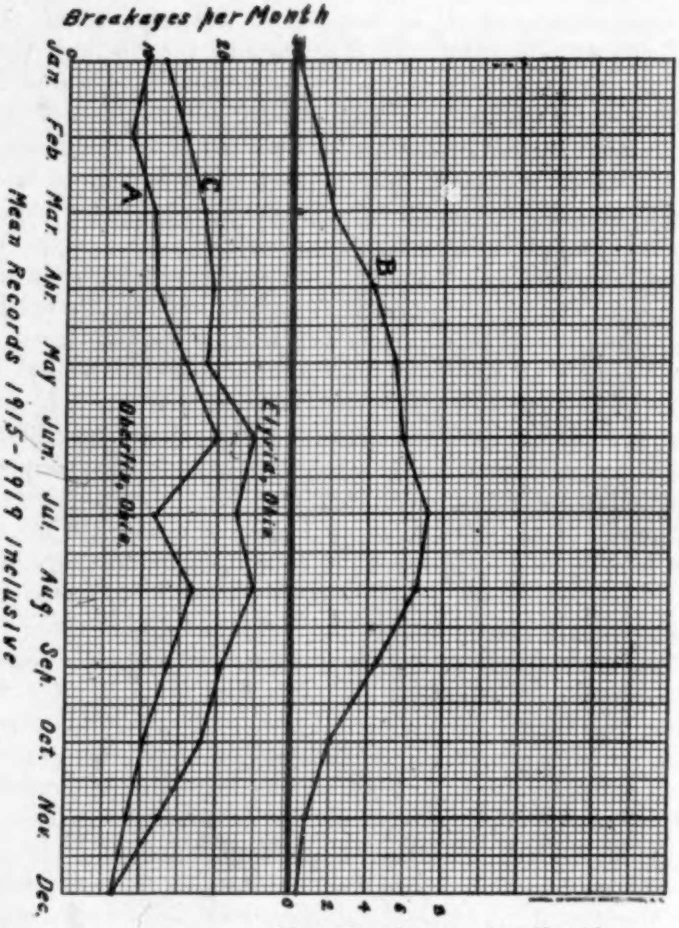


FIG. 1.

of watch-springs a very easy one, if we may take as a criterion of the number of springs broken, the number which are brought to the jeweler for replacement.

To ascribe this breakage to electricity may be ruled out at once for the mainsprings are coiled in a metal barrel, which in turn is inside of a metal case and the combination makes absolute protection against any electrical disturbances. Magnetic effects were looked for but none could be discoverd.

Through the courtesy of Messrs. Herrick and Shreffler of Oberlin, Ohio, and Mr. Chas. H. Savage of Elyria, Ohio, they allowed a search of their records to be made and the number of mainsprings replaced each month was recorded over a continuous period of five years, 1915, '16, '17, '18 and '19. The average number replaced each month for the period of five years was then plotted as ordinates and the time in months as abscissa. In curve A, Fig. 1, is shown the composite curve for the five years as taken from the records of Messrs Herrick and Shreffler, while curve B, Fig. 1, shows the average number of thunder-showers per month over the same five years as were taken for curve A. Oberlin is a college town of about 4,300 inhabitants, to which is added for nine months of the year a student population of 2,000 from the middle of September until about the middle of June. A large percentage of Oberlin's population is away for the summer so we may expect a dropping off of replacements during July, which is the month most of the people go away for a vacation. In Fig. 1, curve C shows a similar study from the records of Mr. Savage of Elyria, Ohio. This town has a population of more than 20,000 and the number of inhabitants remains much more constant during the twelve months than does Oberlin. Even in curve C, Fig. 1, there is shown a drop in the breakage during July which may be ascribed to the vacation habit. That is, people are not at home during July to have their watches repaired.

The data from which curve B, Fig. 1, was plotted was obtained from the weather reports for Cleveland, Ohio, as that was the weather bureau station, nearest to Oberlin and Elyria, reporting thunder-showers. There seems to be a real connection between these curves plotted in Fig. 1. If electricity and magnetism are not the causes, what is? Moisture is the obvious answer and so the next study was an experimental one, in which the breakage of pieces of watchsprings under tension was observed when they were in a moist atmosphere and when they were in a dry one. The results seem very conclusive and were carried out by Mr. Herman Seemann, an advanced student in the department of Physics.

MR. SEEMANN'S EXPERIMENTS.

A watchspring was cut into pieces about five centimeters long, each alternate piece being thrown in one pile and the others in another pile. These were put in a state of strain by bending them in a small loop and holding the ends together by a clamping device, Fig. 2. One set of springs was then placed in a jar in which a vessel of water was located and the other set of springs was placed in a similar jar but with a vessel of calcium chloride present to keep the air inside the jar dry, Fig. 3. Both jars were sealed airtight so that the jars remained, one with a saturated atmosphere and the other with a dry atmosphere. These were observed for a period of time and the number which broke in each jar was recorded. The results of a number of different tests are given in—

Table 1.

Exp. No.	Samples in each jar.	Days under observation.	No. broken in dry air.	No. broken in moist air
1	22	7	0	11
2	28	52	0	17
3	30	41	0	10

These are not selected sets of observations but were all of the observations which were made on this particular point. That moisture is not the important factor can hardly be argued.

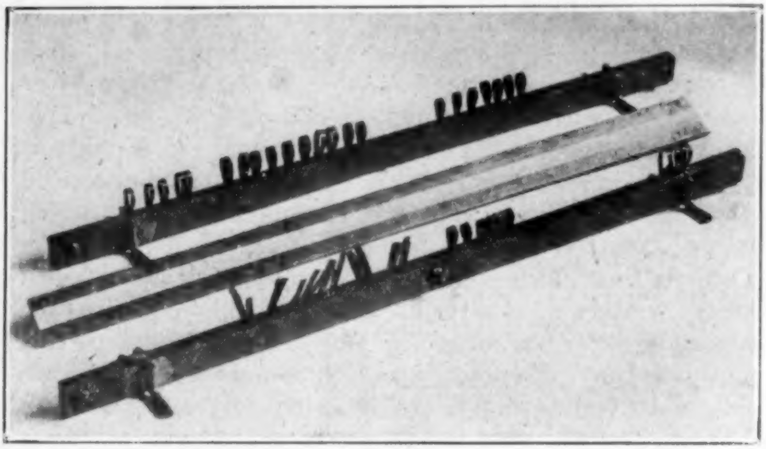


FIG. 2.

Correspondence with a number of large watch manufacturers of the country showed that they held very different views about a seasonal breakage of watchsprings. One thought that if a seasonal breakage did occur it would give a maximum in the winter because, "people foolishly wound their watches

at night after taking them off of their warm bodies and then laying them down on a dresser or bureau where they cooled off and the mainspring contracting made the tension too great and the spring would break. Naturally this would occur most in the winter when the extremes of temperature would occur." Others thought that the maximum would occur in the summer

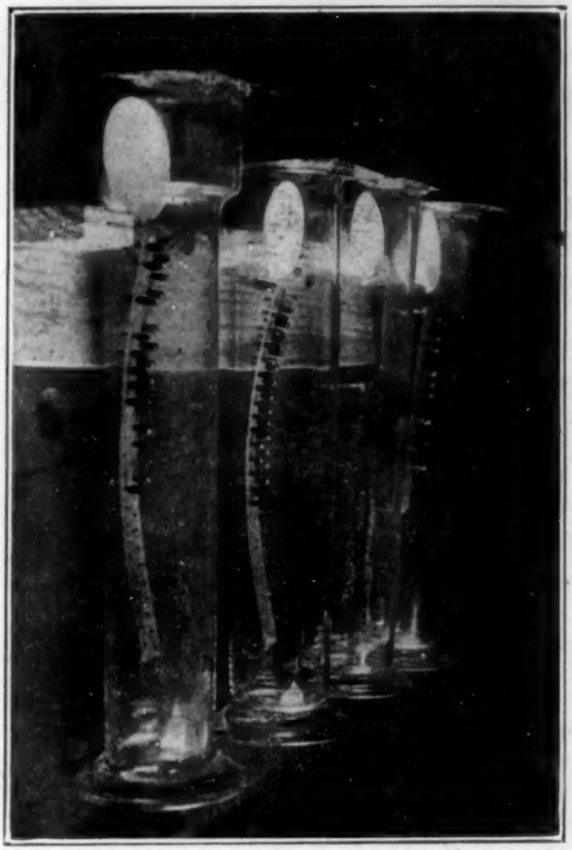


FIG. 3.

but that it would depend on the hardness of the springs used. In table 1 it is to be noted that the springs used were quite different in character and yet the experiments were all carried out in the laboratory which had a fairly constant temperature at the time the experiments were carried out. As one manufacturer wrote, "no scientific tests had been made to ascertain whether atmospheric conditions are the cause of this breakage or not."

Moisture therefore seems to be the main cause of the seasonal breakage. Investigation of the springs under a compound microscope showed minute rust spots at the points where the springs had broken indicating that moisture had promoted rusting there and which had broken the skin effect of the spring. How powerful this skin effect in metals is, was shown by an earlier experience of the author; the rotating table, on which the disc records of a talking machine are laid, is trimmed up in a lathe on an arbor. In trimming up such a table the top surface was taken off and the heavy cast-iron plate curled down in the form of a steel helmet and that in spirte of the trussed form on the bottom of the disc. Once a crack starts the rust works into the fissure causing still greater weakness of the spring at that point and it finally breaks under the tension under which it is placed.

Temperature accelerates the process of oxidation. A group of these pieces of spring under tension, as already described, were placed in a saturated atmosphere and tested at different temperatures for a period of more than fourteen days. It was found that at a range of 37°-39° C., more springs broke than at an average temperature of 18°C. The temperatures at these two limits were controlled by thermostats.

A careful study of the breakage of railroad rails[1] on the Harriman lines over a period of three years shows a marked seasonal breakage there also, but with this great difference that the maximum occurs in the winter time instead of the summer, as we find in watchsprings. In railroad rails we have a condition in which the crystal structure breaks down more rapidly in winter than in summer. It is not a fatigue phenomenon in the case of the watchsprings as is shown by the fact that the springs in the dry atmosphere are under the same tension as those in the saturated medium and yet only those in the moist air break.

If moisture is the chief agent in the seasonal breakage of watch mainsprings, are there any means whereby moisture may be prevented from getting in contact with springs? This would be a preventative measure against breakage. Positive results would also confirm the point of view that moisture was the main cause of the breakage. Oil is a means whereby the springs might be protected from the moisture, so two groups of springs were set up in the frames as before, one group being

[1]Railway Age Gazette, p 1337, June 14, 1912.

oiled and the other as it came from the factory. Both were then placed in the same enclosure containing a saturated vapor. The results were as follows:

Table 2.

Exp. No.	Samples clean.	Samples oiled.	Days under observation.	No. broken clean.	No. broken oiled
4	16	16	33	3	0
5	15	15	12	15	7

Experiment 4 was made on a new spring fresh from the factory while experiment 5 was an old spring which had been lying around in the laboratory and showed rust spots before being oiled. It is quite evident how efficacious the oil is in protecting the springs. It would indicate that jewelers might profitably run a campaign of preventative treatment of watchsprings, where an ounce of prevention would be worth a pound of cure.

It must be borne in mind that not all mainsprings which break are caused to do so by moisture. Some break because of mechanical imperfections. These mechanical imperfections are being picked out by magnetic means here in this laboratory in the hope that we shall be able, by starting with mechanically perfect watchsprings, to reduce the breakage to a minimum by keeping the springs free from moisture.

If one could study the mainspring breakage per capita in different parts of the country it doubtless would be found that the number would be smaller in dry sections than in the humid portions.

The author takes this opportunity of thanking most heartily those jewelers who have so kindly placed at our disposal their records of mainspring replacements.

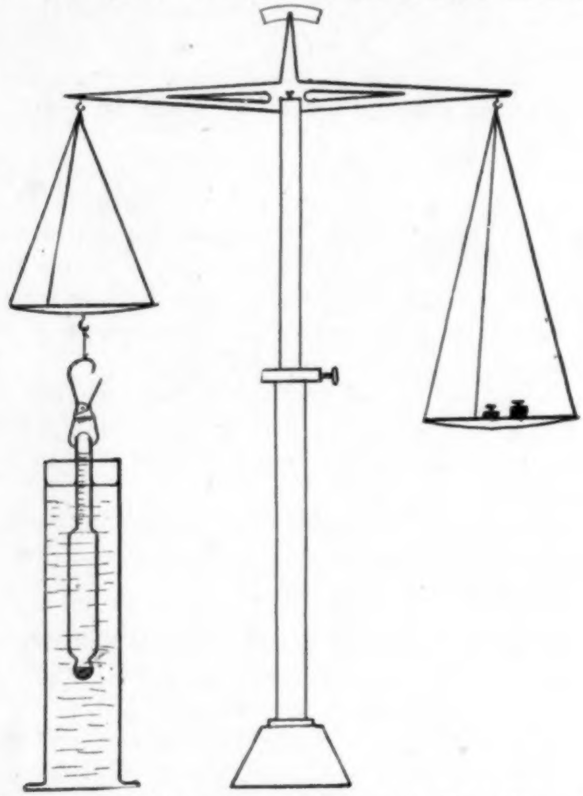
TEST OF A VARIABLE IMMERSION HYDROMETER.

By Paul F. Gaehr,

Wells College, Aurora, N. Y.

In testing such a hydrometer, the simplest procedure is to have a series of stock solutions, whose densities have been accurately measured. This method is very simple for laboratories in which a great deal of this work goes on; but even there, the densities of the solutions is apt to vary on account of evaporation. In the High School laboratory, or the average college laboratory, the storage of a number of stock solutions is usually inconvenient. I have therefore devised an experiment which is capable of great accuracy, and which also helps the student to a better understanding of Archimedes' Law.

For liquids heavier than water: The apparatus required is a jar of water, a spring clamp which will grip the hydrometer stem, and a balance which can be adjusted as to height. Attach the clamp by a light wire or spring to the under side of one of the scale pans and find its weight w. Attach the hydrometer (*not* immersed), and find the combined weight w+H, from which H may be found by subtraction. (The clamp should be as light as possible—preferably not more than 1 gram.) Now bring up the jar of water, allowing the hydrometer to float in the water. Adjust the height of the balance until the beam



is strictly horizontal for a weight H′+w in the other scale pan, this weight being slightly in excess of w. Observe the reading R of the hydrometer. Add 0.2 grams to the weights in the balance, and readjust the balance for horizontality of the beam, and read the new position R, etc., until the entire stem has been covered.

Now take any one case. From H′+w and w we get H′ by subtraction, H′ being the "apparent weight" of the hydrometer

in water. H−H′ is the weight of the water actually displaced. To find H−H′ it is not necessary to go through all the subtractions indicated above, but merely from (H+w)−(H′+w). Now suppose that the hydrometer (without the clamp on top) is placed into a liquid of specific gravity, S, so that the hydrometer sinks to this mark R at which it was held in the water jar, then the weight of the displaced liquid is equal to the weight of the hydrometer, H. The ratio of this weight H to the weight of an equal volume of water, H−H′, is the specific gravity of the liquid.

An "Actino-hydrometer" was tested, its scale not being described in any book. It was first tested by being placed in a series of salt solutions, whose specific gravities were carefully determined. It was found that the hydrometer readings, when plotted against specific gravities gave a straight line. Then the specific gravities as determined by the above method were plotted on the same sheet, and three of the points lay on the line, and the remaining point was only slightly off. The data are given here.

$$\begin{array}{rl} H+w & =15.57 \text{ grs.} \\ w & =\ 4.23 \\ \hline H & =11.34 \end{array}$$

R	H^1+w	$H-H^1$	s
29	4.8	10.82	1.0480
39.5	5.0	10.62	1.0678
53	5.2	10.42	1.0883
67	5.4	10.22	1.1097

If your Jolly balance is of the kind whose lower end is always brought to the same point, the *upper* end of the spring being moved for adjustment, the experiment can be equally well and quickly performed, and with almost the same accuracy.

If the hydrometer to be tested is for *liquids lighter than water*, it becomes necessary to have a wire frame which grips top and bottom of the hydrometer, to the bottom of which is attached a sinker sufficiently heavy to pull the hydrometer down to the top of the stem. In this case it is necessary to find in *each* case the apparent weight of the wire frame, care being taken to have the same degree of immersion of the frame with hydrometer in and out of the jar. This makes the method a little cumbersome. An alternative method is to use the clamp only, attaching the sinker directly to the bottom, and then computing its apparent weight from its specific gravity.

Consideration of the above experiment will show that it has possibilities from the point of view of the teacher, in illustrating thoroughly various applications of the law of Archimedes.

THE CONVENTIONAL EXAMINATION IN CHEMISTRY AND PHYSICS VERSUS THE NEW TYPES OF TESTS.—PART II.

By Earl R. Glenn,
The Lincoln School of Teachers College, Columbia University.

I. Summary of Part I.

In a previous article[1] we summarized the conclusions of psychologists with respect to *inherited capacity, ability* and *performance*. A recent committee report[2] describes these same terms as follows:

"The term 'capacity' should be restricted so that it may connote just one thing: namely, inborn or undeveloped possibilities of behavior. Ability should be regarded as the product of experience acting on capacity. The term 'performance' should be used to connote the score obtained in a test. When, however, there is a desire to convey the idea of comparison with norms or standards, the term 'achievement' should be used. The score of an individual in a test should not be considered as a measure of his ability but as a record of his performance under the particular conditions under which the test was given. Judgments as to ability are always inferences from performance and the greater the number of trials or tests from which ability is inferred, the greater the probable correctness of the inference."

We also pointed out by tables of test ranks for chemistry and physics that *performance* is likely to vary from test to test but the average of several performances is fairly stable. The relative advantages and disadvantages of the new types of tests were discussed.

II. Some Possible Uses of Tests and Scales.

According to the report[3] mentioned above,—"A test composed of elements of uniform difficulty or of several cycles of uniform difficulty, and used to determine the rate at which work is done, should be called a 'rate test.' (Illustration,—Courtis Writing Test.) The term 'scale' should be applied only to tests that are material graded in difficulty, or quality, and used to measure degree of difficulty or quality. A test composed of elements graded in difficulty and used to determine the most difficult test material the subject can handle successfully, under the prescribed condition, should be called a 'performance scale.' (Illustration,—Trabue's Completion Test.")

[1] Glenn, Earl R. "The Conventional Examination in Chemistry and Physics Versus the New Types of Tests: Part I." Sch. Sci. and Math. (21), Oct. 1921.
[2] "Rep. of Stand. Com. of Nat. Assn. of Dir. of Ed. Research." Jour. of Ed. Research, June 1921, 78-80.
[3] See footnote 2.

The chief purpose of any test or scale should be to improve the teaching process. If a reliable scale for high school chemistry or physics were available now it is probable that evidence could be rapidly accumulated which would enable us to:

1. Evaluate the aims of instruction in terms of the measured results obtained.
2. Decide what items of subject matter are not learned thoroughly enough to be worthy of a place in the course.
3. Decide whether chemistry or physics should be taught in the 9, 10, 11, or 12 grade.
4. Determine the most advisable sequence of topics.
5. Select a more efficient teaching emphasis.
6. Show a disinterested person the type of contribution these subjects make to general education.
7. Determine the usefulness of mental tests in indicating probable school success in these subjects.
8. Test one teaching method against another:
   (a) The project method versus prearranged subject matter.
   (b) The textbook method versus the method that uses a combination of demonstration and individual laboratory experiments.
   (c) Etc.
9. Test one plan of study against another:
   (a) Supervised study versus the study hall.
   (b) The school study room versus home study.
10. Determine when to release bright pupils for optional work, after certain legitimate standards have been achieved.
11. Determine whether a student is making satisfactory progress.
12. Discover how much progress a student makes in a given time.
13. Compare the achievement of classes in the same and in different schools.
14. Show the relation of the size of the class to the efficiency of instruction.
15. Determine whether a class is making the desired progress.
16. Be more intelligent in deciding whether a pupil should pass or fail in the subject.
17. Compare the achievements of boys and girls.
18. Determine whether prospective college freshmen have any control of the high school course.
19. Classify college freshmen upon the basis of ability in the subject.
20. Show college professors what may reasonably be expected of good high school instruction in these subjects.

III. Some Preliminary Tests.

In order to study the possibilities involved in the construction of a physics scale, the following tests have been printed in a preliminary edition of 2,000 copies each. About 1,500 sets of these tests were sent out to physics teachers for use at the end of the year 1920-21. Some results are reported in this article. The complete report will appear later. These tests may be secured for use by those who are sufficiently interested *to give the tests according to directions, and send us the data* and the *used tests for further study.*

1. Physics test LP. This is an information test of the completion type and is designed to be used at the end of the first or second semester. (Forms A, B, and C.)

2. Physics test TF. This is a true-false test that can be used at the end of the first or second semester. (Forms A and B.)
3. Physics test MC. A short test dealing with the biography given in the most commonly used physics texts.

The following tests have been tried out also but are not available, except in small quantities, until printed:

4. Physics text PS. This test involves problems requiring numerical solution. (Forms A and B.)
5. Physics test ED. This test deals with problems which do not require a numerical solution. (Forms A and B.)
6. Physics test F. All of the formulas that are commonly used in texts are covered in this test. (Forms A and B.)

Tests PS, ED, and F are written so that Form A is used the first semester and Form B the second semester. It is important for the reader to remember that none of these tests are *standardized tests*. However, they have been prepared with more care than most examinations ever receive. In the revised form, they are probably more reliable and useful than many teachers would be willing to admit. Further investigation will indicate the functions and limitations of such tests.

Those who are interested to try chemistry tests should get into communication with the author of a recent article[4] in this journal.

IV. How to Give Tests.

A. Due to the fact that many teachers regard the conventional examination as entirely satisfactory and open to no serious objections, it is important that the instructor consider the following points in giving such tests as are suggested in this discussion.

1. The teacher should have an open mind and give the tests a fair trial.
2. Follow the directions.
3. Do not use the subject matter of the tests for "cramming" purposes.
4. Do not undertake more testing than you can complete accurately, realizing that mistakes are likely to occur in the first trials.
5. Do not be disturbed if practically all pupils fail on *some* questions.

B. The science teacher should remember that we are chiefly interested in *accuracy* in this investigation. If representative test scores can be secured from a wide range of classes which have been tested according to *the same set of directions*, it will be comparatively easy to determine whether such tests are of any value in teaching.

At present, scores made by any particular individual, class, or school are not important. Since the teaching emphasis controls the grades made upon any test, it is likely that there will be several questions that almost every pupil will miss. Such questions *should not be omitted* from the test.

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[4]Powers, S. R. "The Achievement of High School and Freshmen College Students in Chemistry." Sch. Sci. and Math. *21*, 366-77. (Address, University of Minnesota.)

C. *Before you study the test carefully,* rank the pupils on the score sheet that is provided. (See the blank forms below.) Place the name of the best student at the top of the page. Record the name of the second best student in blank number 2. Rank five of the best pupils at the top of the page. Count the number of pupils in the class. Rank a group of five of the poorest pupils at the bottom of the page. Put the name of the poorest pupil at the bottom and rank the others toward the top.

We are interested only in the relative rank of pupils. Do not give two or more the *same rank* even though they have the *same average* by your marking system. In the end there should be as many rank numbers as there are pupils in the class.

Some writers have suggested that for large numbers and properly selected matter, etc., etc., the various percentages receiving the different grades would be approximately as follows:

Grade:	A	B	C	D	E
Per cent receiving grade:	7%	24%	38%	24%	7%

We are not primarily interested in the distribution of class grades but it is important that we know those who belong in the A and E groups.

D. In all of this ranking consider the average of three or more grades if possible. The semester or yearly grades can be used. *Do not use the results of one test or performance to secure the class rank.*

When you have selected the best pupils and the poorest pupils, rank the remainder of the class in the medium group. The best student now has a rank of 1 and the poorest has a rank at the bottom of the list, the number being the same as the class enrollment, in case all pupils take the test.

E. These tests should be made a regular part of the school work so that pupils will have a fair chance to respond to them properly. It is best to use pencils rather than pens. Do not give the class the idea that they are going through an "ordeal" or "brain test." Require attention and obedience but give the test in an agreeable manner. The test should appeal to the student as a piece of work to be well done. It is best to give these tests *before* rather than *after* any final examinations given by the school.

F. Make no changes in the test. If you regard some of the questions as too difficult or as not properly stated, give the test in its present form and record your objections on the score sheet.

G. When successive classes are to be tested, give the test to all classes on one day and score the papers the next day. If no copies of the test reach the succeeding classes, little error will be introduced into the scores of these classes.

Avoid such unusual school conditions as the following:

1. A half holiday or a special celebration.
2. A period following great excitement in the auditorium.
3. A long period of final examinations.
4. An unusual shift in the daily program.
5. Any event which tends to destroy the quality of the daily school work.

H. Some important details:

1. Give the test with *no previous* announcement or review.
2. Do not permit any questions to be asked during the test.
3. See that the desks are cleared of all books, papers, etc. If possible, arrange pupils so that copying will not be a temptation.
4. Distribute the tests with the directions up. Ask the pupils to fill in the blanks without examining the test itself. Next ask the pupils to read the directions silently as you read them aloud to the class.
5. When the blanks have been filled in and the directions read, start all pupils on the test at the same time. Record the time of beginning and closing the test.
6. Unless otherwise directed give each pupil all the time he reasonably needs for the test. Be sure that pupils record the time used.

V. How to Score Test Papers.

The papers may be scored by means of a stencil by the instructor or a reliable student. This is the most accurate method, but it requires more time to obtain the scores for a class. Students can be taught to do this scoring.

In this preliminary work the class method of scoring may be used as follows:

1. Distribute the tests to members of the class so that no pupil gets his own paper. Take account of any strong likes or dislikes of individual students in order that papers may be scored correctly the first time.
2. The instructor should take the key that is furnished and read the correct answer for each question. *Do this at a fair rate of speed.* Pupils should make a check mark (√) in the blank space ( ) near each correct answer. A cross (X) should be made near incorrect answers. If the student has made no attempt to answer the question make no mark near the question. The checks (√) indicate the correct answers; the crosses (X) the incorrect answers. Students frequently use all sorts of check marks. *They should use these that have been described in order that time may be saved in checking the papers.*
3. Ask pupils to total the score for each part of the test as follows:
   (a) Completion test. Count the number of correct answers for the score.
   (b) True-false test. The score is obtained by subtracting the wrong answers from the right answers, i. e.,
   Score = Right − Wrong.
   (c) Matching test. Count the number of correct answers.
4. In order to find out how many pupils answered each question correctly proceed as follows: Give each pupil a sheet of paper marked off in squares numbered 1, 2, 3, 4, 5, etc. A pupil should write the

name of the individual whose paper is being graded on the sheet and then sign his own name. Ask pupils to put a check mark (✓) in the square for each question that is correct. This sheet, which for convenience we shall call the "number sheet," should be filed with the test. The use of the sheet will be described later.

5. Next call for the final scores, *b fore the papers are returned to the owners.* Write the scores on the blackboard, in rank order from best to poorest. *Ask for scores only, not names of pupils.* Before returning the test papers and number sheets to the owners make sure that the pupil who scored the paper puts his own name on both test and number sheet.
6. At this point both test papers and number sheets should be returned to the owners. The instructor should read through the correct answers again in order that pupils may see whether the tests have been properly scored. Pupils should check the number sheet, also mistakes should be corrected and the doubtful cases considered after class.
7. Before the papers are collected ask pupils to make sure that all blanks are filled out; the scores recorded; and the number sheet correctly prepared. The tests can be filed in rank order according to the score sheet by calling first for the paper at the bottom of the list.
8. In entering the data on the score sheet, check some typical papers for scoring mistakes. In assigning rank numbers for the test use as many numbers as there are pupils. If several pupils make the *same score* use the following plan. Suppose the 5th, 6th, and 7th pupils make a score of 24. In order to give them the proper rank add 5, 6, and 7, and divide the sum by 3 (no. of pupils concerned). This gives each of the 3 pupils a rank of 6. The rank numbers then are 1, 2, 3, 4, 6, 6, 6, 8. We have ranked 8 pupils and we have 8 rank numbers.
9. The quickest method that we have discovered for finding the number of pupils who answer each question correctly is to cut the paper of the number sheet into strips then clip off the various numbers into appropriate piles. The separate tickets of like number can then be counted and the total recorded on the score sheet.
10. The test papers should be filed away in the order given on the score sheet.

VI. Measures of Central Tendency, Variability, and Correlation in Test Scores.

It has been customary to use only the arithmetic mean as a measure of comparison in dealing with examination grades. This practice neglects the fact that two classes may have exactly the same grade or score and yet differ widely in achievement because of marked difference in deviation from the arithmetic mean. In other words, the mean when used alone, may actually be misleading.

More than *one numerical measure* is needed to describe adequately any class of data that may be used for comparison. The following terms are commonly used in statistical work.

A. Measures of central tendency
   1. The *arithmetic mean* is the name of the sum of a series of scores divided by the number of scores. From a statistical point of view this term is very useful but in some cases it gives too much emphasis to very high or very low scores.
   2. The *median* is defined as the score or point on the scale on each

side of which one half of the measures fall. The median lacks certain desirable statistical properties but it is easily computed and is becoming more common in educational work.

3. The *mode* is that score which occurs most frequently. The mode has no particular mathematical usefulness, but it is readily shown in a graph by the "peak." The mode tends to vary more than the median or the mean.

B. Measures of variability

1. The *range* is the difference between the highest score and the lowest score, and as such it includes all of the scores. At best the range is only a rough measure of the variation of the scores about the average.
2. The *quartile deviation* is defined as half the distance between the first and third quarter points on the scale giving the distribution of the scores. It includes about one half of the scores and is computed by the formula, $Q = (Q_3 - Q_1)/2$.

The following blank forms will be found convenient for recording the necessary data.

Score Sheet for Test..................................

1. City.................... 2. State.................... 3. School....................
4. Grade.................... 5. Room.................... 6. Teacher....................
7. Date.................... 8. No. pupils.................... 9. No. pupils tested......
10. Test given by...... 11. Test scored by........ 12. Class No..................
13. Scores recorded by.................... 14. Minutes per week in laboratory and class room..
15. Class has studied subject..weeks.
16. Textbook used..
17. Test began.................................... 18. Test ended....................................
19. The 25 percentile.................................... 20. The 50 percentile....................................
21. Median score.................................... 22. Q. D....................................
23. r.................... 24. P. E.................... 25. ....
26. Unusual conditions:

Rank	Name	Rank in test	Test score	Age	Grade	No. pupils answering correctly					
						Ques.	No. right	%	Ques.	No. right	%
1						1			32		
2						2			33		
3						3			34		
4						4			35		
5						5			36		
6						6			37		
7						7			38		
8						8			39		
9						9			40		
10						10			41		
11						11			42		
12						12			43		
13						13			44		
14						14			45		
15						15			46		
16						16			47		
17						17			48		
18						18			49		
19						19			50		
20						20			51		
21						21			52		
22						22			53		
23						23			54		
24						24			55		
25						25			56		
26						26			57		
27						27			58		
28						28			59		
29						29			60		
30						30			61		
31						31			62		

3. The *standard deviation* is defined as the square root of the arithmetic mean of the squares of the deviations from the average of the distribution and is computed by the formula,

$$\text{S.D.} = \sqrt{\frac{\Sigma d^2}{N}}$$

The standard deviation includes about the middle two-thirds of the scores and is one of the best measures of variability.

4. The *mean deviation* is the arithmetic mean of the deviations from the average, the deviations being summed without regard to sign. This term includes about the middle fifty per cent of the scores.

Since both the mean deviation and the standard deviation require considerable numerical computation, we shall use only the range and quartile deviation in this discussion to suggest the "spread" or variability of the scores about the average.

Having determined the status of the average of the class score in terms of the median and the degree of concentration or variability of these scores in terms of the range or quartile deviation, how do the results compare with the scores that should be obtained? Are the scores distributed in accord with the abilities of the class as inferred from other performances? Do these scores bear any relation to scores made on intelligence tests? In order to get evidence upon these and other similar questions we need still another measure.

C. Measures of Relationship

1. The *coefficient of correlation* is a simple number that expresses a relation between two sets of data. It is based upon the changes in order or ranks of the various pupils in the two groups. This coefficient may vary from plus one (+1), where there is perfect correlation, to minus one (−1) where the inverse relation exists. A value of positive one(+1) would mean that a pupil who ranks first in the intelligence test would also rank first on the science test, while a value of minus one (−1) would mean that the pupil who had first place on the intelligence test would have the last place on the science test.

One writer says that a positive correlation of .7 is about the limit in most educational tests that are given under present conditions. The reader should note the values of the correlation coefficients in the results given below.

VII. Graphical Representation of Test Scores.

A graph will often emphasize significant facts in numerical data that would otherwise not be apparent. Some useful types are:

1. Graph to show the order of difficulty of test questions. In giving questions their proper score value, it is necessary to know how many pupils answered each question correctly. It is usually worth while to graph these percentages.
2. The column diagram. This form is a useful device to show the individual pupil his score with respect to the class as a whole. This can be done by placing the pupil's initial in the appropriate square.
3. The frequency polygon and the "smoothed" curve. If one is interested to know the general form of the curve that is obtained from a frequency polygon involving a limited number of cases

the original data should be plotted. The "smoothed" curve may then be obtained by making the necessary computations.

VIII. Some Typical Results: June, 1921.

Table 1: Physics Test LP (Possible score = 85)

1. School	A	B	C
2. School year (grade)	12	12	12
3. Text	Tower, Smith, and Turton	Gorton	Millikan and Gale
4. No. of pupils	33	26	21
5. Highest score	76	72	83
6. Median score	57.8	53.5	66.7
7. Lowest score	49	28	53
8. Term of school (mo.)	9	9.5	9
9. Correlation with teacher's marks	.78±.045	.64±.077	.69±.076

Table 2: Physics Test LP (Possible score = 85)

1. School	D	E	F
2. School year (grade)	12	12	12
3. Text	Millikan and Gale	Black and Davis	Black and Davis
4. No. of pupils	25	17	30
5. Highest score	82	74	68
6. Median score	56.7	54.2	57.2
7. Lowest score	35	31	33
8. Term of school (mo.)	10	9	9.5
9. Correlation with teacher's marks	.70±.070	.80±.060	−.004 ± .122

Table 3: Physics Test TF (Possible score = 100)

1. School	A	B	I
2. Grade	12	12	12
3. Text	Tower, Smith, and Turton	Gorton	Millikan and Gale
4. No. of pupils	33	26	25
5. Highest score	52	42	60
6. Median score	26.5	21.8	24
7. Lowest score	−2	−10	−4
8. School year (mo.)	9	9.5	10
9. Correlation with teacher's marks	.82±.039	.60±.084	.55±.096

Table 4: Physics Test TF (Possible score = 50)

(Form A or B used alone)

1. School	J (Form A used)	K (Form B used)
2. Grade	12	11
3. Text	Adams	Millikan and Gale
4. No. of pupils	45	30
5. Highest score	42	28
6. Median score	12.8	15.3
7. Lowest score	−8	2
8. School year (mo.)	10	9
9. Correlation with teacher's marks	.46±.080	.56±.084

The results on the four remaining tests will be published at a later date.

IX. The Interpretation of Test Scores and the Improvement of Teaching.

We have previously suggested that the ultimate purpose of a test should be the improvement of the teaching process. If

statistical methods will bring order where chaos now exists, we should be able to discover the defects and apply the remedies at the proper time. However, statistical processes, in themselves, do not supply *proof;* they enable us to simplify a complicated set of data.

If such tests as have been described do nothing more than indicate the topics which need to be retaught they will be useful. When the instructor knows the percentage of pupils answering each question correctly, he can then decide whether certain topics require a different teaching emphasis, or omission from the course.

A low median score with a wide range in the distribution of the scores and little or no correlation between the teacher's judgment of the predicted and actual performance of the class, may mean any one of many things. At a later date we shall discuss all of these points in detail, but it may be suggestive to mention a few possibilities now.

1. The ability of the class may cover a wide range.
2. The teaching emphasis may be improperly placed.
3. The teaching methods may need overhauling.
4. The test may not have been given under fair conditions.
5. The elements of the test may not be properly selected.
6. The subject matter may not be appropriate or wisely organized for class use.

In conclusion, we wish to say that, for the most part, we have *assumed* that the commonly accepted subject-matter is entirely satisfactory for class use. With this in mind these tests have been constructed to measure some of the products of the present instruction in secondary schools.

THE SECOND-FOOT OF WATER.

"Second-foot," as defined by the United States Geological Survey, Department of the Interior, is an abbreviation for cubic foot per second and is the unit for measuring the rate of discharge of water flowing in a stream 1 foot wide and 1 foot deep at a rate of 1 foot per second. It is generally used as a fundamental unit in measurements of stream flow.

"Second-feet per square mile" is the average number of cubic feet of water flowing second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

An "acre-foot" is equivalent to 43,560 cubic feet and is the quantity required to cover an acre to a depth of 1 foot. The term is commonly used in connection with the storage of water for irrigation.

A flow of 1 second-foot equals 7.48 United States gallons a second, 448.8 gallons a minute, or 646,317 gallons a day. As a California "miner's inch" equals 0.187 gallon a second, there are 40 California miner's inches in 1 second-foot.

AN ANALYSIS OF AN EXPERIMENT IN TEACHING FIRST YEAR MATHEMATICS.[1]

BY INA E. HOLROYD,

Kansas State Agricultural College.

For several years the writer has been interested in the work of first-year mathematics—the problem of what to teach and how to teach it. With this problem in mind she has taught during the past two years seven classes in college entrance algebra. It is to set forth the salient points in the presentation of the subject, and in the results obtained in what she believes to have been a very satisfactory experiment, that this paper is written.

The text used as a basis for this work was *Fundamentals of High School Mathematics*, by Rugg and Clark, a text of the "unified" type, though conservative, but constructed upon the conviction that ninth grade mathematics needs a complete reconstruction rather than a reorganization. The outstanding features of the course are: (1) Selection of subject matter on the criteria of "Social Worth" and "Thinking" outcomes; (2) The unique arrangement of the material. The first semester algebra develops symbolism and the equation. A very rational presentation of signed numbers and a new method of teaching factoring, constitute the chief features of the second semester algebra. The text was supplemented in the second semester by material chosen from one of the conventional texts.

The primary aim in teaching mathematics is not so much to impart facts as to develop a mode of thought; namely, a problem-solving or scientific attitude of mind, the ability to analyze and see relationships in new situations, to express these relationships, and to determine them. This requires clear ideas and sound associational processes and cannot be developed without much practice in meeting real problem situations. For this reason the central idea throughout the course was that of problem solving.

The underlying meanings of the course in algebra may be classified under two headings; namely, the narrower associations of ideas that have to do with developing the various phases of the subject, and the broader basic concepts of the equation and functionality. The mental processes in these two classes are the same; namely, the association of ideas in past experiences with the new ideas presented by the new technical vocabulary of the subject.

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[1]An abstract of a discussion given before the Kansas Association of Mathematics Teachers.

Arithmetic deals with quantitative ideas expressed by words or by numbers. Numbers are symbols representing a high degree of abstraction. Algebra, on the other hand, deals with the devices of manipulating these quantitative ideas through the use of letter symbols for numbers. This is a much higher degree of abstraction. We must agree, however, that the mastery of this symbolism plays a very important part in the mastery of the subject.

The first problem involved in learning algebra is, then, the development of its symbolism, how and why to represent numbers by the use of symbols. A student is likely to get on very much better in his use of symbols and in his appreciation of their meaning if the economy of time and of mental energy obtained by their use is stressed. Hence the meaning of symbolism is best fixed by associating with symbols the idea of abbreviation, of "representing" or "standing for."

A clear grasp of the significance of the use of letters to represent numbers can come only by the most gradual transition from the use of words to the use of letters as symbols for numbers. Letters are highly abstract in that they represent no particular content, and the pupil must bridge this gap between his past experiences and the new situation expressed by this abstract symbolism. If he is carried forward too rapidly in the course, or if too many things are attempted, there is introduced an element of guess work and confusion which explains many of the failures in this subject.

Association is the basis of habit formation, and the whole process of learning is a process of establishing a system of habits such that a correct response comes with a given situation. The law of habit formation is repetition, hence the pupil needs not only gradual transition from word symbols to letter symbols, but also much repetition. Therefore the inclusion, as in one traditional text, of "$3x+5x$ = how many x?" as the fifth problem proposed for solution is unpsychological and unpedogogical. The pupil can make neither the association with previous ideas as 3 bu. + 5 bu. = how many bu.? nor can he make the transition without much repetition of such material with the intervening step, $3b+5b$ = how many b? Initial letters help to bridge the gap, since the degree of abstraction seems less than with the use of x or y.

As a means of clarifying algebraic symbolism, perhaps the simplest is the construction and evaluation of simple formulas

from arithmetic and geometry such as those for percentage and its applications, for perimeters of rectangles, for areas of rectangles and triangles, for volumes, etc. Problems from denominate numbers suggest a never ending source of supply. "How many eggs are 6 doz. eggs and 2 doz. eggs?" "Using d for 12, how many eggs in $2d+3d$ eggs?" "Change $7y$ (yards)$+6f$ (feet) to smaller units, that is, to inches." "If $y = 3f$, how many f in $4y+6y-3y$?"

Translation is a vital step in the comprehension of algebraic symbolism and of mathematics as a language. Its outstanding phases are recognition of equality between two quantities and ability to express this equality by means of symbols. As a second step in clarifying the idea of symbolism, much translation from algebraic statements into verbal language as well as the reverse is invaluable. Illustrative examples of each:

I. $n+4 = 13$ is the same as the word statement, "The sum of a certain number and 4 is 13;" $4y = 26$ should be translated "The product of a certain number and 4 is 26," or "Four times a certain number equals 26."

II. (a) The "word" method of stating the example.	(a) There is a certain number such that if you add 5 to it the result will be 18. What is the number?
(b) An abbreviated way to write it.	(b) What number plus 5 equals 18?
(c) A more abbreviated way to write it.	(c) No.$+5 = 18$
(d) The best way to write it.	(d) $n+5 = 18$

The functional relation is fundamental in mathematics and is the central organizing principle of algebra. Its method is essentially that of the equation. Although this is conceded by mathematicians, the traditional text does not make it so. In the supplementary text referred to, for example, only 16 per cent of the total problem content of the book is verbal and equational work, while 84 per cent is consumed in formal exercises for the acquiring of manipulatory skill, whereas substantially the reverse is true of the text experimented with. It might be noted here that psychological analyses show, and experience bears out the statement, that skill in the manipulation of an isolated operation does not function effectively when the operation is associated with other operations in new situations. Application is an explicit phase and practice must be given in the

application of the operation to prevent its degenerating into mere rote memory. This neglect to make application of a skill learned, again explains many failures in algebra.

In developing the concept of the equation as representing a balance of values, specific comparison was made with the weighing scale. The meaning of balance is thus fixed and the idea is developed that whatever is done to one member of the equation must be done to the other, to preserve the balance.

The fundamental notion concerning two quantities which "change together" and with it the idea of the "constant" and "variable" are developed in the text used by three methods—the tabular, the graphic, and the equational. The association necessary for connecting the values in the three methods so as to fix the idea that the table, the graph, and the equation set forth the same truths should be clearly brought about. Meanings are fixed only through many responses to situations in which they occur, hence the value of tabulating, graphing and symbolizing by equations the relationships which exist between pairs of variables to give the pupil a grasp of the meaning of functionality. The use of similar triangles and of trigonometric ratios (tan and cos) in problems of finding unknown distances to give meaning to ratio and proportion sets up an association with real experiences and takes the topic out of the realm of the abstract into that of the concrete—the concrete including at any stage all the abstractions previously made and assimilated.

The facts in connection with understanding the step-by-step process by which the child-mind learns would, it seems, convince the thoughtful teacher that first semester algebra is not the psychological place to introduce the subject of signed numbers and their use. The pupil has quite enough to do to conquer the high degree of abstraction involved in literal symbolism and the basic idea of the equation. He cannot take ideas so rapidly and assimilate them; and, moreover, he does not need them. He has at his disposal an amount of intuitive knowledge which will enable him to solve equations of the simpler type as he gradually formulates his axioms. Signed numbers were therefore taken up as the opening topic in second semester algebra. To develop the broad concept of "oppositeness" with the use of positive and negative numbers, specific associations must be made: associating the idea with above and below zero on the temperature scale; with assets and liabilities; with before and after on the time scale;

etc.; the central aim being to fix the meaning of sense in numbers, that positive and negative express oppositeness. It should be clear that the same point may lie in the positive or the negative direction from the origin from which the distances are measured; i. e., the zero point.

A rational presentation of the principles governing the use of signed numbers in the four fundamental operations requires specific association of ideas.

1. Associating with readings of the thermometer at different times to introduce addition; for example:

The top of the mercury column of a thermometer stands at zero degrees (0°). During the next hour it rises 3°, and the next 4°. What is the temperature at the end of the second hour?

If it starts at 0°, rises 3°, then falls 4°, what is the reading?

2. Associating with saving or losing a given amount of money for a given time, introducing multiplication:

If you save \$5.00 a month (+\$5), how much better off will you be six months from now (+6)? Evidently you will be \$30 better off (+\$30). Thus $+5$ times $+6 = +30$.

If you are wasting \$5.00 a month (−\$5.00), how much better off will you be in 6 months from now (+6)? Evidently you will be \$30 worse off (−\$30). Thus -5 times $+6 = -30$.

3. Associating with the making of change or with readings on a thermometer at different places, introducing subtraction:

"If a customer gives the clerk 50 cents in payment for a 27 cent purchase, the clerk begins at 27 cents and counts out enough money to make 50 cents." The clerk begins at the subtrahend, 27 cents, and counts to the minuend, 50 cents.

On a certain day the mercury stands at $-4°$ in Chicago and at $+13°$ in St. Louis. How much warmer is it in St. Louis, or what is the difference between $+13°$ and $-4°$? Naturally, we do the same thing the clerk does, begin at the subtrahend and count to the minuend; i. e., we count from $-4°$ to $+13°$, giving us $+17°$. The difference is called positive because we counted upward. If we counted downward, the difference would be called negative.

The same reasoning may then be applied to the abstract number scale finally dropping even this. Division is taught as the opposite of multiplication: $+8/-2 = -4$, because $(-2)(-4) = +8$, etc.

Perhaps one of the greatest stumbling blocks in beginning algebra is the subject of factoring. It has been estimated that

39% of all recurring errors made by pupils indicate positive inability in particular types of factoring. The traditional presentation of the "57 varieties" or cases of "Special Products and Factoring" results in much loss of valuable time, largely because they are so arranged that the learning of one actually inhibits the learning of the others. The reason for this is that the pupils have acquired skill in the several "cases" which they cannot generalize. An analysis of the learning process shows that if such a generalization could be made in the initial presentation of the topic, much of the difficulty would be removed. As a matter of fact the general quadratic trinomial, ax^2+bx+c, will handle all of the "cases" except that of "common factor," which can be taught in connection with multiplication and division, and $a^3 \pm b^3$ which may be omitted until third semester algebra.

Visual imagery is the predominating feature in the handling of this subject, hence to present many times to the pupil the

$$\underbrace{\qquad\qquad\qquad\qquad}$$

product of two general binomials $(2x+3)(3x+4) = ?$ thus stressing the importance of the middle term greatly facilitates his grasp of the meaning of the process of factoring ax^2+bx+c. Expansion of such products may be motivated by using it as a tool to find areas of rectangles. In all work the pupil should be required to translate his operations into words. Words are the instruments of abstraction and they aid the pupil to analyze the situation. Experience will soon lead him to make classifications for himself; for example, when the binomials are alike he has a perfect square, the bx term being twice the product of the given terms, a fact of importance to him when teaching him to solve the quadratic equation by "completing the square"—or, again, if the binomials are alike except for sign, the bx term is zero. He will observe the converse statements for himself. As soon as the pupil's response to the situation $(\qquad)(\qquad) = ?$ becomes automatic he should reverse the operation and factor, and again appeal to visual imagery as suggested by such a form

$$\underbrace{\qquad\qquad\qquad\qquad}$$

as $15x^2-14x-8 = (\qquad)(\qquad)$. Such a method is well adapted to bring about "logical thinking," and moreover has the added advantage of saving about three-fourths of the time usally allotted to this subject.

It might be remarked here that analysis of the learning processes shows that the most economical place to teach an opera-

tion is in connection with its application. So here, after the five or six recitations necessary for the presentation, factoring is best taught in the solution of equations and in fractions.

Such a procedure as the foregoing does not build any habits which inhibit any other learning and gives the pupil a power of generalization which develops a grasp of the larger aspects of his subject, a thing to be cultivated in every situation with which he is confronted.

Of the seven classes upon which this text was tried out, four were first semester algebra, with a total enrollment of seventy-two students and three were second semester algebra with an enrollment of forty-six students. The students were older than ordinary ninth grade students, the average age being about twenty years, and most of them had not had preparation beyond the fifth grade. About one-third were ex-soldiers receiving Federal Aid for Vocational Training. Of the entire one hundred eighteen students, only five have thus far entered a curriculum requiring mathematics beyond the two units required for entrance, and it is not likely that more than a half dozen more will do so. Of the five mentioned, three took third semester algebra and entered the three hour college algebra course given for students offering one and one-half years of algebra for entrance, while two passed from the second semester algebra into the five hour college algebra course given for students offering only one year of algebra for entrance. All passed their college algebra, three with grades above average. It is worthy of note that of these three two were in the five hour course.

It is the belief of the writer that the very gradual exposition of the text, i. e., keeping "the content of the course just a step in advance of the developing content of the student's mind," in the first semester algebra, gave the classes the momentum which enabled them to begin second semester algebra with the operations upon signed numbers and yet complete the usual work of first year algebra in the allotted time. This she attributes largely to the accumulation of reasoning ability. It was her experience also that the procedure herein set forth not only saved time but that the better methods of presentation gave the students a more complete grasp and insight into the fundamental notions and devices of the subject than had been the result to those receiving the traditional presentation. The proportion of failures in these classes was from 5 per cent to 10 per cent lower than in classes given instruction in conventional texts.

The special aim in first year algebra should be "to give the pupil the ability to use the tools of quantitaitve thinking—namely, the equation, the formula, and the graph." The experience with these students in college algebra would certainly seem to show that emphasis on problem solving nevertheless tends to develop greater skill in the manipulation of these tools than does emphasis on the side of manipulation alone.

Furthermore, the "social worth" of the material presented was far greater for the one hundred or more students who did not take further mathematics than that of the usual traditional text, and this belief was confirmed by the more mature members of the classes. They felt they "had something practical,—something we can use."

AVERAGE ALTITUDE OF PENNSYLVANIA IS 1,100 FEET.

The approximate mean elevation of Pennsylvania is 1,100 feet, according to the United States Geological Survey, Department of the Interior. The highest point now known is Negro Mountain, in Somerset County, which is 3,220 feet above the sea level. Until 1919, when the topographic survey of the area including Negro Mountain was made, Blue Mountain in Bedford County (elevation 3,136 feet) was thought to be the highest point in the State. It is barely possible, as the topographic surveys are extended, that still higher points may be found.

The surface of Delaware River where it leaves Pennsylvania is at sea level and is the lowest point in the State.

PETROLEUM IN ALASKA.

Petroleum was one of the first useful minerals found in Alaska, but the earliest attempts at its systematic development in the Territory were confined to a very brief oil boom that began in 1901 but that soon collapsed, owing to the rapid development of oil in California. All the oil lands in Alaska were withdrawn from entry in 1910, and patent has been granted to only one claim, which is in the Katalla field, where a few productive oil wells have been drilled. In spite of the small developments, however, Alaska has produced about 56,000 barrels of petroleum, all of it taken from the Katalla field. This oil has been consumed locally, most of it by a small refinery near Katalla.

The passage of the oil and gas leasing act of February 25, 1920, started small stampedes to all accessible places where oil seepages were known and led to the staking of many claims, some of them in areas where no indications of oil have been found. Up to September, 1920, the Juneau land office had received 178 applications for oil-leasing permits, covering in all 388,673 acres of land, which by no means includes all the land staked, most of which will no doubt be found worthless as oil land. Systematic drilling for oil will probably be begun in Alaska this year, and oil fields will no doubt be developed in Alaska, but the geology of the Territory, so far as known, does not indicate that any startling discoveries will be made.

Investigations of oil in Alaska were made in 1903 by the United States Geological Survey, Department of the Interior, which has since then from time to time devoted considerable attention to this subject. The Survey has just published, as Bulletin 719, a report entitled "Petroleum in Alaska," by George C. Martin.

SOME PLANE GEOMETRY PROBLEMS.

By Lida C. Martin,
Decatur High School, Decatur, Ill.

This is a set of plane geometry problems which I have been collecting from my students. They were asked to bring in problems which some one actually had to solve. The wording is that of the students, but often in a condensed form, to save space. Some problems which needed figures for explanation are here omitted.

An article on old measuring instruments in School Science and Mathematics for January and February 1910 will suggest other problems.

Lines, Parallels, and Parallelograms.

1. How can you find the center of a long rectangular table in order to put a center piece there?
2. How can you determine whether a figure is a square or a diamond?
3. In putting gas fixtures in our house the men had to find the center of the ceiling. How could they do it?
4. Why do railroad companies always tunnel through a mountain instead of going around or over?
5. In building a picket fence the pickets must be perpendicular to the base and parallel to one another. How is it done?
6. Section men must lay the rails parallel. They use a bar which extends from one rail to another. If the bar fits perpendicularly over both rails they are parallel. Why?
7. In my stamp book I wished to have the base of the stamps on the same straight line although they were different sizes. How is this done?
8. When you are making a garden, how do you get the rows parallel?
9. When a hunter wants to fire his gun he has to use two sights in order to hit the mark. Why?
10. A treasure is buried in Silas Marner's home midway between the sides of his room, running east and west, and is twelve feet from the fire place. Locate the treasure.
11. Knowledge of geometry is essential in making a service flag, in order to construct a five pointed star, locate it and get the white center in properly.
12. Mr. C. is president of the gun club. Having lost the sight of his right eye, he has patented a projection sight on his gun with which he is enabled to sight with his good eye. It is made of heavy wire in the shape of a parallelogram the width being equal to the distance between his eyes, and is fitted to the gun lengthwise. Why is this possible?

Triangles.

1. A piece of felt is 6 ft. by 1 ft. How could you cut 4 pennants from it each triangular in shape, 3 ft. long and with two equal sides?
2. In making a Y. M. C. A. emblem in which one equilateral triangle is inside another, how is the figure made?
3. How can I make a point at the end of a belt and get it true?
4. In making a toy aeroplane the propeller is to be put in the middle of an equilateral triangle. How can I find the center?
5. A carpenter has a board 1 ft. wide and 2 ft. long. He wishes to cut from it a piece that will be an equilateral triangle, one foot on a side. (a) How shall he do it, (b) How many square inches of board will be left, and (c) what is the volume of wood in the triangular piece if the wood is 1 in. thick?

6. A gardener wished to plant a garden on either side of the house, and he wanted to make one exactly in line with the other. In order to do this he had to extend a line through the house. How could he do it?

Steel Square and Angles

1. In making a cross for decoration, how can the standard be erected perpendicular to the arms at the center? Draw one on paper accurately.
2. A plumber is running a pipe in a basement and wants to know whether it is perpendicular to the floor. What does he do to find out?
3. We have a shelf at home in a corner. It is 6 in. wide and extends along each wall 1 ft. We could not get the boards to fit properly. Could we have done it by geometry?
4. Required to fold a piece of ribbon so that it will fit around a square yoke.
5. Find out what a steel square is and make one in same form out of stiff paper.
6. Get an angle of 45° by using a steel square.
7. Bisect an angle by using a steel square.
8. In an oblong room I want to build a triangular shelf with one corner at an angle of 60° and the other at 30°. How can I mark the board before cutting it?
9. How can you find out whether a steel square is true or not?
10. A carpenter lays down his square and measures on each side of it as many inches as there are feet in the sides of the room. Then he connects the points with a ruler. The room is as many feet across from the corner to corner as there are inches on the ruler between points. Why?
11. Construct a regular hexagon with a steel square. Make each side one inch.
12. Construct a regular octagon with a steel square.
13. Required to cut a square, 12 in. on the diagonal, from a piece of board 10 in. wide.

Right Triangles.

1. If a high diver dives off a perpendicular ladder 70 ft. high, and lights 16 ft. from its foot, how long is his dive?
2. If it takes one hour to go over the bridge and along the shore in an automobile and the same length of time to go across the river by boat how many miles per hour does the boat travel? The bridge is 3 miles in length and the distance along the shore is 4 miles.
3. A suitcase is 27 in. long, 16 in. wide, and 7 in. thick. Can an umbrella which is 33 in. long be packed inside of it? This is solid geometry but can be solved by plane.
4. When you come home from school, why do you cut across the vacant lot rather than go around by the sidewalk?
5. An aeroplane traveling at the rate of 60 miles per hour ascends at an angle of 30°. What will be its height two minutes after starting?
6. In making the triangles, which are equilateral, for the Gastman school basketball team members, how high must the altitude be if the sides are 9 in.?
7. How long a piece of lumber is necessary to support a stairway which has 16 steps, each of which has a tread 10 in. wide and is 8 in. high?
8. How long a rope is required to reach from the top of a tent pole 15 ft. high to a peg in the ground 17 ft. from the foot of the pole?
9. How can the diagonal of a room 12 ft. square be found?
10. I have a square piece of goods and I want to cut a three-cornered tie for a middie out of it. How can I do it?
11. In making a feed trough for rabbits I discovered that I was likely to make sides and bottom anything but rectangles. I used geometry and had a neat trough. How did I go to work? Draw a plan of each part on paper.

12. How much goods 20 in. wide, cut on the bias, will it take to put a band 2 in. wide around a skirt 2 yds. wide?
13. How long are the cross pieces for the underside of a table top if the top is 5 ft. by 2 ft. 4 in.?
14. A trunk is 18 in. by 32 in. inside measure. What is the longest umbrella that will lie flat on the bottom?
15. In order to have a band of trimmings 6 in. wide, how much silk must I buy on the bias?
16. A baseball diamond is a square 90 ft. on a side. Find the distance from first base to third.
17. A boy flying a kite let out 425 ft. of string, and the distance from where he stood to a point directly under the kite was 210 ft. How high was the kite, supposing the string was straight?
18. In putting up the football goal posts, the 3, 4, 5 triangle was used. How and why?
19. A woman has a back yard 15 ft. by 40 ft. What is the longest clothes line she can put up?
20. A ladder 78 ft. high stands perpendicularly against a building. How far must it be pulled out to be lowered 6 ft. at top?
21. How would a surveyor erect a perpendicular to a line in a field by the principle of the right triangle, when the chain only is used?
22. If you buy a half yard of silk, measured along the edge, how wide will it be on the bias?
23. How long will a brace for a gate have to be when the posts are 5 ft. high and 8 ft. apart?
24. In decorating a room 2 ribbons are stretched connecting opposite corners of a room 30 ft. by 40 ft. How many yards of ribbon must be bought?
25. How do they lay out the corner of a building before building it?
26. How can you erect a flag pole 100 ft. high so it will be perpendicular to the building roof?

CIRCLES.

1. During my stay in Oklahoma I chanced to be around when a little boy wanted 4 wheels for his wagon. He had a board 1 ft. by 5 ft. How did his father mark the board before cutting out the wheels?
2. How can I find the center of a round locket in order to place a stone there?
3. I have a round hat pin, on which the edges curve down, I wish to paint a figure in the center. How can I find the center?
4. How are the four holes in a button located?
5. One of the boys was making a round table top and lost the center where two small boards were to cross. How could he find it again?
6. How large a circular track can be put in a quarter section of land? (160 rods in a side.)
7. If a man has a cog wheel 8 in. radius and one 6 in. radius, the distance between centers being 2 ft. where would the center of a third wheel of 10 in. radius have to be to fit both of them?
8. It is required to round the corners of a table top 5 in. square. Draw a plan using 1 in. radius.
9. An athletic club owns a triangular piece of ground, 1500 ft. by 1610 ft. by 1725 ft. The club desires to build a circular track 20 ft. wide. How will they locate the center of the circle and outer edge of track so as to get the largest possible track?
10. How can you draw a good oval for the mat of a picture?
11. What is the diameter of a circle whose chord is 4 ft. and the rise to the circumference is 6 in.? This is used in making the top of a door.
12. Across a river a telephone wire is to be suspended from poles on each side. The tops of the poles are level and are 150 ft. apart. The wire sags at lowest point 40 ft. Find length of suspended wire.
13. What is the diameter of the largest round center piece that can be cut from a piece of goods in the shape of a triangle, each side of which is 10 in.?

14. Having a round and a square table each 16 sq. ft. how many more people can sit at one than the other, if the arm space is 16 in. and 8 in. is allowed between two adjacent people?
15. A circus ring is 60 ft. in diameter. How many times will a horse have to circle it close to the outer edge to run one-half mile?
16. How can you place a doily in the center of a round table?
17. When a barber cuts your hair, how does he make it even all round?
18. To make a circular cape when the center neck, and the back, shoulder and front lengths are given, how do you draw the pattern?
19. Wishing to make a circular skirt, I made a circle on the goods with the circumference the size of the waist line. To the radius of my circle I added the length of the skirt and drew another circle with the same center. Was I right?
20. If an auto is going down the street which is too narrow to turn round in, it can turn at the next intersection. Why?
21. How can I find the radius of the filler hole in a gasoline tank, so as to make the plug to be used?
22. In a circular building how do you find the center so as to place a pole there?
23. If a boy walks to school in the summer time 1-2 mile around a circular pond, why in winter does he walk across on the ice? How much does he gain by it?
24. What portion of a log will three men saw if the log is 3 ft. in diameter and they cut the same amount of surface?
25. When they made the street corner round, so the autos could have more room to turn in, how did they get the radius and center to go by?

Similar Triangles. Dividing a Line.

1. I wish to put 4 buttons on a waist, spacing them equally. How can I do it?
2. How can I place 6 ornaments on a hair band and get them equally distant?
3. At the Y. M. C. A. they had a starting line for the 20-yard dash divided into 5 equal parts. The slant was wrong and another line had to be divided. How was it done, using the old line?
4. How can you divide a board into 3 equal strips with a steel square?
5. Required to divide a line into 9 equal parts using a sheet of ruled paper.
6. I have 20 yards of fence to build and only 10 posts. How far apart will I have to place them?
7. How can you mark a piece of paper 4 in. by 6 in. for a calendar and get the squares equal? Do it for this month. Will it be the same for every month?
8. The statement was made, in reference to a halfback, that a man's value to his team varies as the square of his distance from the ball. Is it true and why?
9. The base of a triangular field is 40 rods and the altitude 30 rods. Find the area of the triangle cut off by a railroad running parallel to the base and 10 rods from the vertex.
10. I wanted to see how high a clothes pole was. As I did not want to climb up to measure it I worked it by means of geometry. How?
11. A note book is 13 in. wide. It is required to divide the page into 7 columns of equal width. Do this by means of a ruler divided into inches only. Could it be done as well by using ruled paper?
12. Some pictures had to be reduced in size for a magazine and this method was used. A rectangle the size of the original picture was drawn. The required length was marked off on this rectangle from the corner to point A. At point A a perpendicular was drawn. Then a diagonal of the rectangle was drawn. At the point where the diagonal and the perpendicular met a perpendicular was drawn to the other side. The new rectangle which had the required length was the size of the picture. Why?

AREAS.

1. What is the area of a piece of ground in right-triangular shape when one side is 40 ft. and the hypotenuse is 52 ft. A similar example occurred in the east part of town where the Van terminals are being located.
2. Given a triangular field, how would you find the area using only a chain?
3. Sticks one foot long are laid on the table in the shape of a square and then a diamond. Which area is the larger?
4. How many square feet of concrete will it take to build a 6 ft. walk around a circular fountain 10 ft. in radius?
5. A circular piece of brass has a 10 in. radius. It is desired to cut a circular hole in it equal in area to one-half the disc. What should the radius be?
6. A water main 6 in. in diameter runs 300 gal. of water per minute. What would one 4 in. in diameter run under the same pressure?
7. A city water main is 16 in. in diameter. How many secondary 4 in. mains will it supply?
8. How much longer will it take a 2 in. pipe to empty a tank than a 4 in. one?
9. A circular half-mile track encloses how many acres? Can you have a baseball diamond inside?
10. The boundaries of a square and of a circle are each 64 ft. Which has the larger area, and how much?
11. There is a semicircular arch the outside of which is drawn with a radius of 3 ft. and inside with a radius of 2 ft. It is to be made of 7 stones, all the same size. What is the area of each? Draw a figure?
12. A cracker factory stamped its crackers from dies one inch square. Another factory used circular dies yet its crackers contained as much as the square ones. What was the diameter?
13. Find the area contained in a right triangle of which one leg is 9 chains and the other is 10 chains.

REGULAR FIGURES.

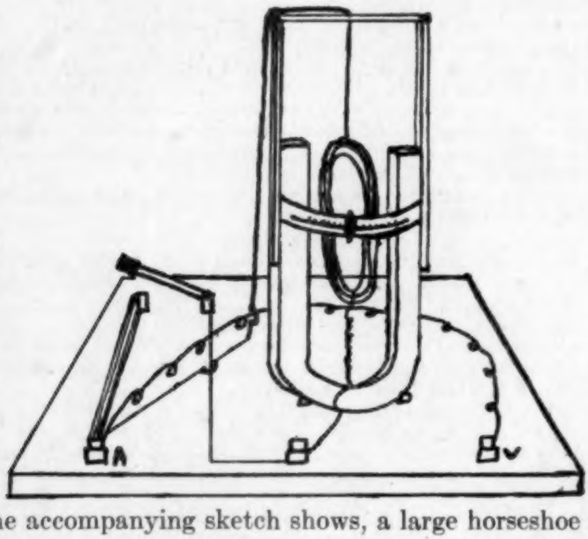
1. When surveyors find the angles included by the sides of a field by means of instruments, they check their work by using the formula ($2n$-4) right angles. Why?
2. In an ideal honeycomb the cells are 6-sided. Why?
3. How can one-half of a round cake be cut into 8 equal pieces?
4. What is the largest equilateral octagon which can be cut out of a square block of wood 4 feet on a side?
5. The sides of a floor are 15 ft. and 6 ft. A man wishes to tile it with hexagonal tiles 6 in. on a side. How many tiles will it take?
6. How many square feet of cement in an equilateral triangle 4 ft. on a side?
7. Given a square foot of copper, find the largest possible hexagon you can get from it.
8. A race track 1-4 mi. in diameter is to be used as a baseball ground. What is the distance a ball may be sent over second base and still be inside the field?
9. How would you space the face of a clock for numerals?
10. A friend wished to make a round doily 6 in. in diameter with 12 scallops. The question was to get those scallops even. How could she do it?
11. A man wished to place 8 shrubs around his circular lily pond. How did he find the places to set them?
12. In constructing gears it became necessary to make 16 cogs in a portion of a disc, 10 in. long, radius of circle 5 in. How may this be done?
13. A man wiring a large room wishes to place 5 lights in a circle, and have them the same distance apart. How shall he do it?
14. Why don't designers of linoleum, carpets, etc., put 5-sided figures on them? What do they put? Why?
15. How could you make a 6-sided bird house, and cut the sides so they would fit and not leave cracks?
16. In making a service flag what geometric principles do you use in making the star?

A HOME-MADE GALVANOMETER.

By Charles H. Dwight,

Norman, Okla.

As a teacher of physics in a small High School during the past few months I have realized what difficulty arises from a lack of adequate equipment. Especially may this be true in regard to electrical instruments which, if worth much for tolerably accurate results, are almost always of high price. The school where I taught had no galvanometer in its physics laboratory equipment and the need for one was very great, although a Weston volt-ammeter sufficed for several occasions when considerable current was used. The following paragraphs tell how I built a rough-and-ready instrument with some supplies at hand.



As the accompanying sketch shows, a large horseshoe magnet is securely mounted, arch down, on a piece of board and a coil of some thirty turns of large copper wire is suspended by means of a light wooden scaffold between the poles of the magnet. Attached to the coil and perpendicular to its plane is a piece of wire which is bent up over a paper scale, the latter a semi-circle and fastened at each end by thumb-tacks to the inside edge of the scaffold. The upper suspension is composed of a piece of No. 30 bare copper wire and the lower is a small coil of No. 40 silk-wound copper wire. The latter is connected to a binding post in the center of the board and the former joins a piece of large wire which terminates at the left-hand binding post (A).

Between this terminal and the central one is placed a knife switch and a few lengths of steel wire to form a shunt. A coil of very fine copper wire leads from terminal A to terminal V.

The strength of the magnet is such and the coil sufficiently large so that when an outside circuit is connected to the two left-hand terminals the instrument acts as a galvanometer. If the knife switch be closed, the resulting shunt allows the instrument to act as an ammeter. With the switch open and the circuit completed thru V instead of A a voltage reading is possible. Lack of uniformity in the field, air currents and the like prevent the instrument in any case from being very accurate, but as a galvanometer indications of current are noticeable when it is employed with, say, a slide-wire bridge, on which the moving contact may be within a couple of cms. of the correct null point. The instrument was calibrated for amperes and volts with standard meters, the ampere range being 0-8.5, the volt range 0-6. These values appear on the scale. The resistance of the galvanometer connection is 0.03 ohm, that of the ammeter side 0.24 ohm and that of the voltmeter part 19.30 ohms (too small for any hope of accuracy).

The properties of the upper suspension largely determine the sensitiveness of the instrument. Ordinary "bell" wire suffices for the coil. The results obtainable as a galvanometer are satisfactory enough for the grade of work attempted. I shall be glad if these hints may prove useful to any High School teacher, and if the complete instrument fail in many respects from an electrical standpoint, it will show quite clearly the mechanical construction of a suspended-coil current measuring instrument.

PRODUCTION OF ASPHALT INCREASES.

The quantity of native asphalt and native bitumens sold in the United States in 1920 was 198,497 short tons, valued at $1,213,908, according to the United States Geological Survey, Department of the Interior. This was an increase of 125 per cent in quantity and of about 78 per cent in value over 1919. Gilsonite was reported from Uinta Country, Utah, wurtzilite (or elaterite) from Duchesne County, Utah, and grahamite from Pushmataha County, Okla.

The sales of manufactured asphalt obtained from domestic petroleum amounted to 700,496 short tons, valued at $11,985,457, or $17.11 a ton. Compared with 1919 these figures indicate an increase of 14 per cent in quantity and 37 per cent in value.

The sales of asphalt manufactured in the United States from Mexican petroleum in 1920 amounted to 1,045,779 short tons, valued at $14,272,862 or $13.65 a ton. This was an increase of 55 per cent in quantity and of 85 per cent in value over 1919.

TEACHING VALENCY.

By Lula Gaines Winston,
High School, Richmond, Va.

There are many mechanical ways of teaching valency. The following method has been used successfully in my own classes and I pass it on for what it is worth.

Beginning with the definition—"Valency is the number of hydrogen atoms an element (or radicals) will unite with or replace," I give in illustration the following list of formulas with which they are already familiar when the subject of Valency is taken up:

HCl $H(NO_3)$ $H_2(SO_4)$ H_2S H_2O $H(OH)$ $H_2(CO_3)$ $H_3(PO_4)$

From this table it is readily seen that the Valency of Cl is Ne$_1$ of (NO_3), one of (SO_4) two, etc.

After the Valency of Cl, (NO_3), (SO_4), S, etc., has been learned by means of thorough drills, it is an easy matter to write most of the formulas which are needed. Suppose the question is to write the chloride, nitrate, sulphate, sulphide, oxide, hydroxide, carbonate and phosphate of iron, which has a valency of 3.

Consulting the list Cl is found to have a valency of 1. Writing the symbols for iron and chloride with the valency over each thus Fe^3C^1l simply transpose the numbers, placing them at the bottom thus:

Fe^3C^1l becomes Fe_1Cl_3 In like manner
$Fe^3(N^1O_3)$ becomes $Fe_1(NO_3)_3$
$Fe^3(S^2O_4)$ becomes $Fe_2(SO_4)_3$
Fe^3S^2 becomes Fe_2S_3
Fe^3O^2 becomes Fe_2O_3
$Fe^3\ (O^1H)$ becomes $Fe_1(OH)_3$
$Fe^3(C^2O_3)$ becomes $Fe_2(CO_3)_3$
$Fe^3(P^3O_4)$ becomes $Fe_3(PO_4)_3$ or $Fe(PO_4)$

The student takes to this quite readily.

It is very important to retain the parentheses about the radical so that the numbers inside will not cause confusion.

For practice it is well to form all the common compounds of a univalent element also. Taking N^1a and proceeding as before N^1aC^1l becomes Na_1Cl_1 or NaCl as the figure 1 following a symbol may be omitted.

$N^1a(N^1O_3)$ gives $Na_1(NO_3)$, or $Na(NO_3)$
$N^1a(SO^2{}_4)$ gives $Na_2(SO_4)$, $Na_2(SO_4)$
N^1a^2O gives Na_2O
$N^1a(P^3O_4)$ gives $Na_3(PO_4)$ etc.

The compounds of a bivalent element are written in just the same way. The only difference is that if the figures following

the symbols are both alike, they need not be expressed:

Using Ca^{11}
Ca^2C^1l gives Ca_1Cl_2 or $CaCl$
$Ca^2(N^1O_3)$ gives $Ca(NO_3)_2$
$Ca^2(S^2O_4)$ gives $Ca_2(SO_4)_2$ or $Ca(SO_4)$
Ca^2O^2 gives Ca_2O_2 or CaO
$Ca^2(O^1H)$ gives $Ca(OH)_2$
$Ca^2(PO^3{}_4)$ gives $Ca_3(PO_4)_2$

Reversing the above method, the valency of a metallic element or radical may be found easily.

Given the formulas

Sb_2S_3, $FeCl_3$, $Ag(NO_3)$, $Na_2(CO_3)$, $Zn(SO_4)$, $Ca(CO_3)$

to find the valency of the metallic part.

Proceed as before, transposing the numbers and placing the numbers which are at the bottom on the top of the symbol. If no number is given after the symbol use 1:

Sb_2S_3 gives S^3bS^2 Sb has valency of 3
Fe_1Cl_3 gives Fe^3C^1l Fe has valency of 3
$Ag_1(NO_3)_1$ gives $A^1g(N^1O_3)$ Ag has valency of 1
$Na_2(CO_3)_1$ gives $Na^1(C^2O_3)$ Na has valency of 1

The only complications arise when the metal has a valency of 2, but by using the list given at the beginning as a check, this case presents no difficulty, thus $Zn_1(SO_4)_1$ gives $Z^1n(S^1O_4)$ But this makes (SO_4) have a valency of 1 while according to the list it has a valency of *2*. From $Z^1n(S^1O_4)$ we see Zn has the same valency as (SO_4) hence Zn has valency of 2. Again using $Ca(CO_3)$ $Ca_1(CO_3)_1$ gives $Ca^1(C^1O_3)$ but (CO_3) according to list has a valency of 2 hence Ca has valency of 2 also.

The method may be extended by placing parentheses properly and the writing of difficult formulas becomes easy.

Take for instance the compound formed by the combination of $K_3Fe(CN)_6$ and $FeCl_2$. The student is bewildered at first; but place a parenthesis thus $K_3(Fe(CN)_6)$ and it is easily seen by transposing the figures and placing them on top thus $K_3(Fe(CN)_6)_1$ gives $K^1(Fe(C^3N)_6)$ that the parentheses has a valency of *3*. Combining the parentheses with Fe^{11} thus $Fe^2(Fe(C^3N)_6)$ we get $Fe_3(Fe(CN)_6)_2$.

It is sometimes an advantage to use the parentheses empty; thus $Fe^2(\ ^3\ )$ gives $Fe_3(\ )_2$ filling in afterwards.

In writing formulas of acid salts simply change the position of the parentheses, thus:

$H_2(SO_4)$ or $HH(SO_4)$ gives $H(HSO_4)$
$H_2(CO_3)$ or $HH(CO_3)$ gives $H(HCO_3)$

It is easily seen that the radicals (HSO_4) and (HCO_3) have a valency of 1 and the student is made to write compounds of a univalent, bivalent and trivalent element using these new acid radicals.

$H_3(PO_4)$ is treated in like manner, thus:

$H_3(PO_4)$ $H_2(HPO_4)$ $H(H_2PO_4)$ giving radicals of valency 3, 2, 1 respectively.

The importance of retaining the parentheses cannot be too strongly emphasized until the student becomes thoroughly familiar with the valency of the different radicals.

ARMY HISTORY.

A complete report of the history, methods and results of psychological examining in the United States Army has been recently published in the Memoirs of the National Academy of Sciences, Volume 15, 1921. The report is edited by Lieut. Col. Robert M. Yerkes, Chief of the Division of Psychology, as an official document for the Surgeon General of the Army. It consists of three parts, bound in a single volume. Part I, presenting the official history of the development of the service and its activities during the war, is supplemented by reproductions of all of the printed materials devised and used in conducting psychological examinations. Part II includes a complete account of the preparation of methods, their characteristics, and their evaluations as practical procedures. In Part III the results of examining are summarized.

The entire report may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at $1.75 per copy. It appears in quarto size, under the title "Psychological Examining in the United States Army," and includes VI+890 pages.

STUDY OF EARLY FOSSILS.

The fossil shells of the early invertebrates, or spineless creatures, are of great importance to geologists, for they indicate the geologic period in which the rock beds containing them were formed—in other words, the age of the rock. Each fossiliferous rock bed contains characteristic forms or groups of forms that determine the period in which it was mud or sand. Former Director Powell, of the United States Geological Survey, once tersely explained to a congressional committee the value of paleontology by saying that it is "the geologist's clock," by which he tells the time in the world's history when any rock bed was formed.

The economic importance of paleontology has been repeatedly shown in this country. In the earlier exploitation of anthracite coal thousands of dollars were fruitlessly expended in New York in search of coal beds, until the New York geologists showed that the beds in that state could contain no coal. The fossils in New York rocks exploited are of Devonian age, whereas the fossils of the Pennsylvania anthracite coal beds belong to the Carboniferous, a much later period. This discovery at once stopped a useless expenditure of money.

In times of doubt and perplexity the geologist therefore turns to the paleontologist for light on the age and original order of the rock beds he is studying. The study of the animal and plant remains that are embedded in the rocks has thus become an important part of geologic work, and although the specialists who are engaged in this study are few, their work is of high importance.

ERRORS IN THE DETERMINATION OF THE HEAT OF FUSION OF ICE.

BY PHILO F. HAMMOND,

University of Wyoming, Laramie.

Certain expressions of principles and certain methods of performing experiments have been used in our text books of physics and laboratory manuals without being questioned for so long that they are, in most cases, accepted as the final word upon that subject. These statements are, so to speak, handed down from one book to another. It would do no harm, in fact, it would be a good thing, if teachers would question these statements and methods, if it were done in the right spirit.

Some years ago when teaching physics in a high school the writer found that the results obtained by students determining the heat of fusion of ice were unsatisfactory because of the large variations in the results obtained. To be sure the calorimeters used were too small, being of the nickel plated tin can form often used for high school work; but even taking into consideration this handicap, the results were not so good as they should have been, and not so good as were obtained later by modifying the method of operation as noted below.

There are two things found in laboratory manuals from which the writer has departed in his work with this experiment, and he has never noticed a manual either for high school or university work which varied from the usual in this particular, although there may be such manuals. The first of these is the direction to break the ice into small pieces and the second is the direction to end with the water as many degrees below room temperature as it was above room temperature at the beginning. The writer found that better results were obtained by using water at from 70° to 80° C.[1] and by using as large pieces of ice as the calorimeter will permit; and he satisfied himself with the explanation: first, that while the ice was supposed to be wiped dry less error could occur with a large piece, if there were a failure in accomplishing this; second, with high temperatures more ice is melted and therefore, the per cent error in determining the amount of ice melted is reduced, and, third, while the radiation per second is much greater at the beginning of the experiment and there is an extra loss by evaporation due to the higher temperature, the time that the temperature remains above that of the room is

[1]Mr. A. J. Conrey, teacher of physics in the Laramie High School, informs me that he has been using high temperatures in performing this experiment, and that he has been getting better results since he began to do so.

short compared with the time that it remains below and thus the amount of heat lost to the room at first is equal to that gained from the room at the last part of the experiment. As the usual directions say to begin with the water at 35° C. and end with it at 5° C., the writer instructed his students to begin with the water between 70° and 80° and end with it between 5° and 8° C. No careful experiment was made to test these conditions, and recent experience seems to show that the third statement, while in the right direction, is a poor guess.

Last winter two boys in general physics, who are unusually careful workers, using two calorimeters to save time, one of which was about twice as large as the other, obtained the results given below. The weighings were made with rough cast weights and a trip balance, but the quantities are comparatively large and, therefore, good agreements were obtained.

Calorimeter	No. 1.	No. 2.	No. 1.	No.2.
Weight of Calorimeter	464 gm.	305 gm.	464 gm.	305 gm.
Weight of Water	1002 gm.	503 gm.	1014 gm.	483 gam.
Final weight	2229 gm.	1179 gm.	2301.5 gm.	1180.5 gm.
Amt. of ice Melted	763 gm.	371 gm.	623.5 gm.	392.5 gm.
Initial Temperature	70.5° C.	69° C.	77° C.	73° C.
Final Temperature	7.2° C.	8° C.	8.5° C.	7° C.
Heat of Fusion	79.6 Cal.	79.0 Cal.	79.5 Cal.	79.09 Cal

It will be seen that the larger calorimeter gave slightly better results than the smaller one, and that all of the results are below the accepted value. One of the boys reported this fact to his instructor and complained that the reason was because the conditions were not right, in that the water remained above room temperature only a short time while it was below room temperature a comparatively long time, and, therefore, the calorimeter absorbed more heat from its surroundings than it gave up to its surroundings. This of course would make the results too low in accordance with the data given above.

To test out the accuracy of this statement the writer made three trials given below, but due to the fact that there were so many things for one person to look after and that the help available at that time was not experienced in taking laboratory data, it was impossible to get extremely accurate data and no claim is made in that direction. The accuracy can be judged to a certain extent by the values obtained for the heat of fusion which were 81.6, 80.2 and 80.5 in the order in which the trials are given below. However, the general results show plainly the point under discussion. The large calorimeter, Number one, was used and, therefore, the quantities are relatively large.

In the first trial a single piece of ice, weighing 639 grams, was introduced into 978 grams of water at 79.5° C., which lowered the water to 17.5° C. The room temperature was high, 26° C., and, therefore, the beginning was 53.5° above room temperature and the ending 9.5° C. below room temperature and the time during which the water at the outer edge close to the calorimeter remained above room temperature was 60 seconds, and the time during which it was below room temperature was 120 seconds. Judging from the value of the heat of fusion obtained the data were not so accurately taken as in the following trials.

In the second trial one fairly large piece of ice and several small pieces weighing altogether 834.5 grams were introduced into 1008 grams of water at 78° C. The final temperature was 8° C.

Beginning 52° above room temperature.

Ending 18° below room temperature.

Time above room temperature, 80 seconds.

Time below room temperature, 5 minutes, 40 seconds.

In the third trial two pieces of ice of about the same size, both together weighing 698 grams, were introduced into 939 grams of water at 78°C., with a resulting temperature of 12.2° C.

Beginning 52° above room temperature.

Ending 13.8 ° below room temperature.

Time above room temperature, 50 seconds.

Time below room temperature, 3 minutes, 40 seconds.

The ice was pushed up and down in the water with a stirrer as it is in an ordinary experiment of this kind. The time was taken with an ordinary pocket watch and is, therefore, not extremely accurate. It was our intention to take more data with some under the conditions outlined by the laboratory manuals, but we used the last of the ice on hand and since no more was needed for laboratory use a new supply was not obtained, and the other trials were, therefore, neglected.

The data are sufficient, however, to raise a question regarding the directions given in laboratory manuals, and the directions used by the writer in his own work as well. Considering the second trial, for example will the calorimeter lose as much heat during the first 80 seconds due to the evaporation and the greater radiation at that temperature as it will gain during the 340 seconds that it is below room temperature?

If instead of starting at 78° C. the water had been 44° C. so that the water at the start would have been 18° above room

temperature and ended 18° below room temperature, more water in proportion to the amount of ice would have been necessary. We used 834.5 grams of ice in an equivalent of 1051.6 grams of water. Suppose that instead we had used 547.6 grams of ice in an equivalent of 1338.5 grams of water at 44° C. calculation shows that at 8° C., the ice would be melted and that we would have the same final weight. In the actual trial at room temperature, 26° C., we had about 320 grams of ice yet unmelted in an equivalent of 1566 grams of water, but had we begun with the water at 44° and with other quantities mentioned above, we would have had the same amount of unmelted ice in the same amount of water at room temperature. This we have calculated, but it is easy to see that since we have in both cases the same final temperature and the same quantity of water at the end there must be the same amount of unmelted ice at room temperature. The time, therefore, that the calorimeter is below room temperature must be the same in each case, other conditions being the same. It appears quite evident that 547.6 grams of ice placed into 1338.5 grams of water at 44° C., will cool the water to room temperature as quickly as 834.5 grams of ice placed into 1051.6 grams of water at 78° C., will cool the water to room temperature, and that there cannot be a great difference. We will have to conclude, therefore, that if the directions of the manuals are followed, the time that the calorimeter is above room temperature is very short compared with the time that it is below room temperature. The question then is will the calorimeter lose as much heat by radiation and evaporation while above room temperature in 80 seconds as it will absorb from the room in 340 seconds while it is below room temperature? It is probable that if the student begins at a fairly high temperature and ends with the temperature but a few degrees below that of the room, absorption and radiation would come more nearly equalizing each other More experimental work will be necessary to settle this point, however.

Here is a field for research work within the possibilities of most high school teachers and within reach of the equipment of the high school laboratories. We may have been doing an experiment for the past seventy-five years in the same way, but because we have no proof that we have been doing it in the best way, there is always an opportunity for the progressive teacher to test out different methods, and possibilities that may suggest themselves as the work is covered from year to year.

DOES MISSISSIPPI RIVER FLOW UPHILL?

"Does Mississippi River flow uphill?" is frequently the subject of school debates, and such debates usually arise from inaccurate or indefinite uses of the terms "uphill" and "downhill."

In answer to a correspondent who recently made this inquiry, the United States Geological Survey sent the following reply: Some people describe "down" or "at a lower elevation," when referring to two localities, as the one nearer the center of the earth, and consider the "upper" of the two as the one farther from the center. If only a small area is considered this is practically true, but in referring to widely separated localities, such as the source and the mouth of Mississippi River, such a definition would lead to an absurdity and must therefore be incorrect.

The surface of water at rest is a level surface, as that phrase is usually understood. Any particle of matter above such surface will be at a higher elevation, and if acted on by natural forces alone will tend to go down toward the water. Mean sea level is the surface generally accepted as the datum or reference plane for all topographic elevations.

The source of Mississippi River is about 1,500 feet above mean sea level. Therefore, the unrestrained water at the source of the river, under the action of natural forces, tends to go down to sea level at the river's mouth.

As the equatorial radius of the earth is about 13 miles greater than the polar radius, and as the intermediate radii differ in length between these limits, and as the source of the Mississippi is nearly 19° of latitude farther north than its mouth, it follows that the mouth of the river is about 4 miles farther from the center of the earth than its source. The combined effect of gravity and centrifugal force makes the water of the river run downhill, although actually the water moves away from the center of the earth in doing so.

ARE THE SEASONS CHANGING?

By Clarence J. Root,

Meteorologist, Weather Bureau Office, Springfield, Ill.

It is probably the experience of every Weather Bureau official to hear remarks similar to this: "The seasons are changing. We do not have the cold weather we did when I was a boy." With the exception of a few months in 1795, continuous temperature records have been maintained at New Haven, Conn., since February, 1780. The data used in this discussion were taken from the records of various observers from 1778 to 1872 and from those of the Weather Bureau station at New Haven from 1873 to the present.[1] The writer has averaged the annual mean temperature values by decades, with the following results:

For the 10 years ending—	Mean temperature (F.), degrees and tenths.
1790	49.6
1800	50.0
1810	50.4
1820	47.5
1830	49.3
1840	47.8
1850	49.2
1860	48.9
1870	49.1

1880	49.7
1890	48.9
1900	49.7
1910	49.7
1920	50.5

It will be noted that the warmest three periods are those ending in 1800, 1810, and 1920, and that the coldest decade immediately follows the second warmest.

Considering the individual months and the individual years, it is found that the coldest January occurred as late as 1857. The coldest February occurred 8 years after the warmest one. The coldest March was as late as 1870 and again in 1885. The coldest April was in 1874, and many years after the warmest one. In May we find a number of years with the same lowest temperature—1812, 1815, 1870, and 1882. The highest figures in June are in 1779, 1790, 1803, and 1876. In July the lowest was in 1816, with the warmest as early as 1780 and as late as 1876. The coldest August occurred 61 years after the warmest. In September the coolest months are in the earlier years, but for October, November, and December the coldest year came after the warmest year in each case.

Thus it will be seen that in nine months of the year the coldest one of record occurred after the warmest one. These figures seem to indicate very clearly that since the time of the Revolutionary War, at least, there has been no permanent change in temperature.—[*Monthly Weather Review.*

[1]The earlier observations are published in the *Transactions of the Connecticut Academy of Sciences*, vol. 1; they are summarized and combined with the Weather Bureau records in the *Annual Meteorological Summary for 1920*, published by the Weather Bureau office at New Haven, Conn.

THE PORCELAIN LAMP.

"The Porcelain Lamp," a classic in educational filming, made by the Harry Levey Service Corporation for the Cole Motor Car Co., of Indianapolis, Ind., showing in a beautiful story the discovery of gasoline and its explosive powers, as applied to locomotion, will be distributed gratuitously through the exchanges of the National Non-Theatrical Motion Pictures, Inc.

This picture, which is in five reels, will be loaned to any exhibitor in the United States *absolutely free of cost*, with the exception of transportation charges. If you care to use this picture write to the New York Exchange, National Non-Theatrical Motion Pictures, Inc., 230 West 38th Street.

This offer is made to the non-theatrical exhibitor and for the express purpose of emphasizing the extremes which have been resorted to by the makers of these films to develop an interest in the public mind in the evolution of transportation problems ever since mankind first displayed a preference to riding rather than walking. Travel in foreign climes and the rather obsolete methods of transport, which are still the vogue in some countries, form interesting features of this picture and its geographical, historical and ethnological features especially adapt it to school use and classes in either or all of these departments of study. Its story and its general concept makes it of particular value in the schools of manual training or wherever automobile assembling and construction is taught. Its attractive story and bright, crisp, explanatory titles form the elements that so forcefully plant the lesson deep in the ever receptive mind of the student, who insists on visual as well as oral instruction. The regular exhibitor is equally welcome to avail himself of this magnanimous offer.

TO THE TEACHERS OF MATHEMATICS IN MISSOURI.

We are confronted by the most hopeful outlook for the teaching of mathematics in our secondary schools that we have seen for a number of years. The reason for this is the unity and co-operation among the teachers both for the purpose of improving subject matter and methods of teaching, and to raise the standards of scholarship and of technical preparation of teachers. This gratifying outlook has been made possible by the getting together of teachers in conventions and in committees for the exchange of ideas and methods and to plan for further progress.

Probably the most important organization in recent years for the promotion of mathematics teaching in the country is the National Committee on Mathematical Requirements, under the auspices of the Mathematical Association of America. This committee is composed of distinguished educators and mathematicians from the high schools and the universities of the country. Due to the generous financial support of the General Education Board of New York City, this committee has labored for more than two years, adjusting courses and methods in mathematics to present day ideals and conditions. In doing this they have secured the united co-operation of more than one hundred teachers' organizations.

Realizing that the National Committee would soon cease to exist, and knowing that the great work thus begun ought to be carried on to completion, the teachers organized the National Council of Teachers of Mathematics at the City of Cleveland in the spring of 1920. The purpose of this organization is, therefore, to perpetuate the work of the committee through its annual meetings, and through its official organ, Mathematics Teacher.

The success of the council depends not only upon the enthusiastic efforts of individual teachers, but also on the active support of sectional, state and local organizations. May we count on you for the support which you can give in making the state organization as well as the council a success. Plan to come to the annual meeting of the State Teachers' Association in St. Louis, November 2-5. Watch for the announcement of the program of the Mathematics Section.

PLANT COLORS IN MAIZE.

As a result of studies carried on for the past dozen years, R. A. Emerson, Professor of Plant Breeding, at Cornell University, has just issued a monograph on "The Genetic Relations of Plant Colors in Maize."

This publication is issued as Memoir 39 of the Cornell University Agricultural Experiment Station. It contains about 120 pages and eleven color plates. To those who are interested in the research problems of plant breeding copies will be sent as long as the supply is available.

It should be kept in mind, however, that Memoir 39 is a highly technical publication and does not treat, in popular form, any of the problems involved. Requests should be addressed to the Office of Publication, College of Agriculture, Ithaca, N. Y., asking merely for M-39.

AFGHANISTAN.

While the arrival in Washington of an envoy from the Mohammedan kingdom of Afghanistan to seek to establish diplomatic relations with the United States does not signify that that country, hitherto sealed against Christian missionaries, will be opened to them, or even that governmental representatives will be exchanged, it does indicate that one of the world's most isolated countries is showing a readiness to abandon, in some measure, its rigid exclusiveness. This state, which is one of the very few regions, with an organized government, in which the establishment of Christian missions has never been permitted, is the subject of the following bulletin issued from the Washington, D. C., headquarters of the National Geographic Society:

Slowly the forbidden places of the earth have been opened to civilization, Christian missionaries, and commerce. China and Japan long ago opened their portals. Turkey permitted free access. Korea, once "the Hermit Kingdom," threw down her barriers. Among all the considerable nations, only Afghanistan and Tibet now remain "posted"—to use a poacher's phrase—against the world. And of the two, Afghanistan because it is a country of virile militant people, perhaps commands the greatest attention.

Situated between the southern-growing empire of Russia and northern spreading British India, Afghanistan has been the typical buffer state; its natural exclusiveness, due to religious fanaticism, has been accentuated by the political rivalries of its great neighbors.

Forbidden Lhasa itself is no more exclusive than brooding, suspicious Kabul, the capital of this isolate, unfriendly realm of fanatic tribes, of rocks, deserts, irrigated valleys, and towering unsurveyed ranges.

No railways or telegraph lines cross this hermit country or run into it, and its six or seven million people have been hardly on speaking terms with any other nation.

Night and day, from stone watchtowers and hidden nooks along the ancient caravan trails that lead in from India, from Persia and Russia—trails used long ago by Alexander and Jenghiz Khan—squads of bearded, turbaned Afghans, with imported field-glasses and long rifles, have kept watch against trespassers from without.

For reasons of foreign policy, the Amir has long felt the necessity of secluding his little-known land to the greatest possible extent from the outside world. Only a few Europeans, mostly British, but occasionally also an American and now and then a few Russians or Germans, have had permission to come into this country and to sojourn for a while in its curious capital. But even on such rare occasions as when a foreign engineer, or a doctor whose services are badly needed, is admitted by the grace of the Amir, the visitor is subject to a surveillance that amounts almost to imprisonment.

"Splendid isolation" is a sort of Afghan tradition, a conviction that the coming of the foreigner will spell the end of the Amir and his unique, absolute rule.

Today no other monarch anywhere wields such undisputed authority or is in closer touch with the every-day life of his subjects. He personally runs his country's religion, its foreign affairs, and he even supervises much of its commerce. He also owns and censors the only newspaper printed in all Afghanistan. Incidentally, he keeps fifty-eight automobiles, and he never walks. Even from one nearby palace to another, he goes by motor over short pieces of road built especially for his pleasure.

From the World War, though he took no active part in it, the Amir emerged with singular profits. His old and once rival neighbors, Great

Britain and Russia, drawn together as allies in the world conflict, left him a free hand, and in 1919 Great Britain officially recognized the political independence of this much-buffeted buffer state, to whose rulers she had so long paid a fat annuity.

With an area of 245,000 square miles, Afghanistan is, next to Tibet, the largest country in the world that is practically closed to the citizens of other nations. But political life at wary, alert Kabul is in sharp contrast to the meditative seclusion and classic aloofness of the pious lamas at Lhasa. Amir Amanullah Khan, through his agents in India and elsewhere, is in close touch with the world's current events; and, as the last remaining independent ruler of a Moslem country, now that the power of the Caliph at Stamboul is broken, he wields a far-reaching influence throughout the Mohammedan world; also, because his land happens to lie just as it does on the map of the world, it is plain that for a long time to come he will be an active force in the political destinies of middle Asia. Like Menelik of Abyssinia, Queen Lil of the Hawaiian Islands, or the last of the Fiji kings, this Amir, remote and obscure as his kingdom is, stands out in his time as a picturesque world figure.

The Amir's word, his veriest whim, is law to his millions of subjects. He is, in truth, the last of the despots, a sort of modern Oriental patriarch on a grand scale. His judgments are, of course, based primarily on the Koran, or on the common law of the land; for there is no statute book, no penal code, and no court.

The Amir reserves to himself the right of passing death sentences. The cruel Afghan forms of punishment, such as shooting a prisoner from the cannon's muzzle, sabering off his head, stoning him to death, burying him alive, cutting off his hands and feet or putting out his eyes, are seldom employed nowadays; yet often the criminal himself will choose a quick, though violent, exodus to paradise rather than suffer long imprisonment in a filthy iron cage, perhaps to die eventually of starvation.

The way of the transgressor in Afghanistan continues to be uncommonly hard, however. Time and again, in the recorded history of this land, deposed amirs, troublesome relatives, and political enemies have been deliberately blinded, there being a tradition here that no man with any physical affliction may hold a public office of honor or profit.

Politically, Afghanistan is divided into four provinces: Afghan Turkestan, Kabul, Kandahar, and Herat. Topographically, its most conspicuous features are the high peaks in the northeast where it touches the great Hindu Kush, the Tirach Mir attains a height of more than 23,000 feet.

Through these mountains of northeast Afghanistan wind some of the most picturesque and historic trails of the whole world. For centuries the trade between Turkestan and India has flowed over these high passes, and the story goes that often these annual caravans number as many as 120,000 loaded animals, including camels, mules, and horses.

Afghanistan is a Bable of races and tongues; more than half its population are not Afghans at all. The majority group embraces the Iranian-Aryan Tadjiks, who inhabit the settlements and large towns; the Mongolian Hazarahs, who roam the mountainous central regions of the country and the Turkomans and Uzbegs of northern Afghanistan. The real Afghans, or "Pahtos" (Pathans), as they call themselves, live in the high ranges stretching from the Solimans past Ghazni and Kandahar to the west, toward Herat.

The tribes are divided into minor clans, called "Khel," and they live almost entirely off their herds of cattle, camels, and sheep. Here, as in India, deaths from snake-bites are numerous; scorpions and tarantulas also enliven the nomad's life, and in winter the felt-floored tents are

alive with vermin. Few real Afghans are found in the settlements or towns. They instinctively cling to the wild, free life of the open ranges.

War is the chief occupation of all these tribes; they constantly quarrel among themselves and seldom intermarry.

Though the language of the Afghan originated from the old Iran idiom, it shows now the mark of Indian influence. In writing, the Afghan uses a sort of Arab character—that is, one of those alphabets which as children we used to call "fishworm letters." His meager literature, modeled after the poetry of Persia, is also influenced by Islam.

Persian culture has molded the social life in Afghanistan through centuries; notwithstanding the religious hatred between the Sunnis and the Shias, Persian customs have been more or less adopted in the upper ranks of all middle Asiatic Moslem society.

From the Persians the Afghans got the idea of marrying more than one wife; but, like the Persians, too, they have found, to their dismay, that polygamy is nowadays a most expensive custom.

Sometimes, when the Amir wants to favor his faithful officials with presents, or perhaps to play practical jokes in certain cases, he distributes women among them; but these "gifts" often prove so troublesome that no great degree of gratitude is apparent among the recipients.

Family life, however, seems to be rather more intimate and private in Afghanistan than in Persia. Usually the young Afghan does not see his bride before the day of the wedding. Female relatives conduct the preliminary skirmishes, a sort of courtship by proxy which is later followed by negotiations between the bridegroom and his future father-in-law.

Marriage is celebrated at a very early age, especially in the northern parts of the country, where boys of fourteen marry girls of not more than ten or twelve years of age.

Amir Habibullah Khan (who was assassinated in 1919) had a harem of 100 women and among these, strangely enough, were a few Europeans. The present Amir, Amanullah Khan, has but one wife.

The women of Afghanistan are kept in more rigid seclusion and are more closely veiled than the women of any other Moslem land. Like the Arab, the Afghan considers it unnecessary and even unwise that women should learn to read or write. No girls are admitted to the bazaar schools and no mullahs are employed to teach them, and Afghanistan knows nothing of women teachers.

In spite of their illiteracy, however, many individual Afghan women wield no little influence in tribal affairs, and, as a rule, the wives of the upper classes lead a comfortable and apparently happy life. They are lavishly provided with every luxury of food and dress which Afghan means can afford, and they visit constantly from one harem to another to gossip, sing, and play games. To be left childless is counted life's saddest misfortune.

About the time the little girls of the family put on their veils, the boys of the same age must begin their studies. First of all, a boy is taught to ride; then to hunt and shoot. The horse is the Afghan's constant companion.

The education of middle and lower class boys is in charge of the mullahs, or teachers. Usually a shabby house or convenient nook in the bazaar is utilized as a school-room, the boys sitting on the floor and studying aloud. The pupils are often surrounded by an interested group of long-haired, wild-looking camel-drivers or visiting nomads.

The government contributes nothing to maintain public schools. Often the better families send their sons to be educated at universities in India.

The Central Association of Science and Mathematics Teachers Annual Meeting

Friday and Saturday, November 25-26, 1921
Soldan High School, St. Louis, Mo.

FOR the second time in its history, the Central Association will have its annual meeting at St. Louis, Mo. A most enthusiastic group of members from that vicinity has been and is working with the officers of the Association to assure the success of the meeting. Programs have been arranged which will be interesting and profitable. These programs will be received by all members of the Association and by some 4,000 other teachers and school officials in the central states early in November.

All who can do so are urged to come to the meeting. It will do you good and it will add to the success of the meeting. Arrangements are being made to get reduced rates on the railroads. The success of this effort depends upon our ability to get 350 or more paid fares into St. Louis from the contiguous territory. Help make the effort successful by being one of the 350! Details concerning the arrangements will appear in the annual program, or may be learned by inquiry directed to Mr. M. J. Newell, Evanston High School, Evanston, Illinois. Mr. Newell has special charge of arrangements for gathering a group who will leave Chicago in a body. You would enjoy being with that group.

All present and past members should at once send in their annual dues to the Treasurer, Mr. L. L. Hall, Morgan Park High School, 11043 Hermosa Ave., Chicago, Illinois. He is authorized to accept \$2.50 as payment of dues for the year 1921-1922. Others interested in good instruction in science and mathematics are invited to join the Association. You profit by so doing even if you cannot come to the meeting because your annual dues entitle you to a year's subscription to School Science and Mathematics and to any other publications of the Association. This year it is hoped that publication of the Proceedings will be resumed. Inquiry about the Association may be directed to the Secretary, Mr. Glenn Warner, 7633 Calumet Ave., Chicago.

—THE OFFICERS OF THE ASSOCIATION.

MISSOURI SOCIETY

The program of the Mathematics Section of the Missouri State Teachers Association to be given in St. Louis, Mo., at the regular annual meeting early in November:

The Future of Mathematical Education, by Professor Chas. N. Moore, of the University of Cincinnati.

Mathematics from the Standpoint of the Junior College, by Miss Leolian Carter of the Central High School, St. Joseph, Mo.

Mathematics from the Standpoint of the Junior High School, by Principal H. H. Ryan of the Ben Blewett Junior High School, St. Louis, Mo.

The National Committee on Mathematical Requirements, and the National Council of Teachers of Mathematics, by Dr. Eula A. Weeks, of the Cleveland High School, St. Louis.

Professor Moore will also address the Secondary Section of the Association on, What a High School Graduate Ought to Know. Professor Moore is a member of the National Committee on Mathematical Requirements. The Missouri teachers are very fortunate in having this opportunity of hearing him.

ALFRED DAVIS,
President of the Mathematic Section.

STEREOSCOPIC PROJECTION.

At the meeting of the French Photographic Society, held on April 22 last, says L. P. Clere writing in *The British Journal*, a very interesting experiment in stereoscopic projection was made by M. Maurice Miet. He used a positive transparency made from the ordinary stereoscopic negative without the usual transposition. The image to be viewed by the left eye was projected on the right of the screen, and that to be viewed by the right eye, to the left. Stereoscopic viewing was obtained by crossing the directions of the ocular axis, namely, by looking at an object held for an instant at a short distance from the eyes. The new feature, in this experiment of M. Miet's, consisted in using, as this object, a card in which a square aperture was cut. A card of about half-plate size, with a square hole about two by two inches, serves well when held in front of the eyes at about 1-20th of the distance of the eyes from the projection-screen. Although this mask cuts off the two side images, which, in this mode of viewing usually enclose the central stereoscopic image formed by the superimposition of the two component images, it reduces considerably the strain of observation, and avoids the sudden separation of the superimposed images which readily takes place when this simple accessory is not used. The effect of relief produced in this way is positively striking; but is seen only by persons who have acquired the ability to see stereoscopically without a stereoscope. Moreover, it imposes a strain on the muscles of the eyes, as does the use of an improperly adjusted stereoscope. The members of the audience who, in these circumstances, saw the steroscopic effect, were asked to raise their hands and were found to be in a minority. But there is no need to resort to projection in order to ascertain the absence of the power of seeing steroscopically of the many people who prefer to close one eye when asked to look into a stereoscope. The process is so simple that it can easily be experimented with, and its repetition would interest many photographic societies so long as the exercise is limited to not more than a dozen views on the screen, so that there may be no excessive strain of the eyes.—*Photo Era.*

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

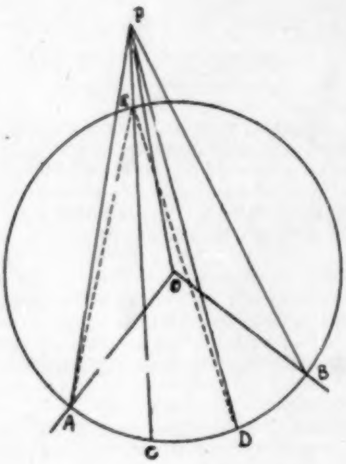
All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

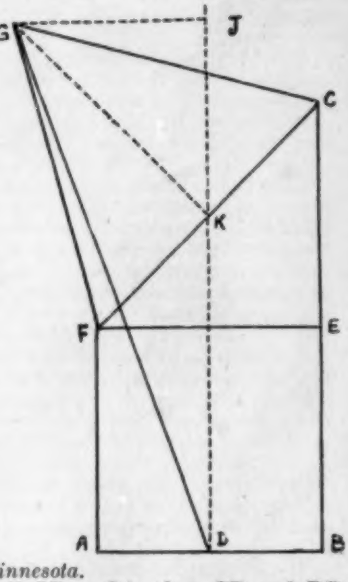
The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. A. Nyberg, 1039 E. Marquette Road, Chicago.

SOLUTION OF PROBLEMS.

701. *Proposed by Arthur H. Lord, Classical High School, Lynn, Mass.*

AOB is a right angle and arc ACDB its quadrant trisected at the points C and D. P is a point on the bisector of the reflex ∠BOA. Prove that CP and DP do *not* trisect ∠APB.





Solution by F. A. Cadwell, St. Paul, Minnesota.

The statement is inaccurate because if OP = OA, then CP and DP *will* trisect APB, for in that case the three angles thus formed will each be measured by half of the equal arcs AC, CD, and DB. Hence the problem is confined to the two cases in which OP is greater or is less than OA.

If OP > OA, complete the circle of which arc ACDB is a quadrant, and let E be the point where CP intersects this circle. Draw EA and ED. △PEA = △PED because PE = PE, ∠CPA = CPD, if the proposition is true, and ∠PEA = ∠PED; and hence PA = PD. Also △POA = △POB so that PA = PB. Hence, from the point P we have three equal secants, PA, PD, PB drawn to the circle, which is impossible.

If OP < OA, we may consider the triangles as before and prove PA = PD = PB, so that we have three equal lines from a point within a circle, not the center, to the circumference, which is also impossible.

Also solved by *E. Tabor, Upper Lake, Cal.;* and by *Clara L. Hancock, Pipestone, Minnesota,* by showing that if the angles were equal then certain other angles must be both greater and smaller than a certain number. Several readers merely stated that the angles could not be equal for then

it would be possible to trisect an angle, which we know is an impossibility. The editor chose this problem for the department because in almost every geometry class there is some pupil who thinks he has solved this impossible problem, and in most cases the solution is based on the trisection of a right angle. Here, then, is a very simple proof of his error. The statement that from a point we can not draw three equal secants to a circle is itself a good exercise, not difficult but very interesting; the editor has never seen it in any text.

702. *Proposed by James Smith, Brooklyn, New York.*

Find to how many decimals the following approximate construction for $\sqrt[3]{2}$ is correct: ABC is a right angle with BA = 1/2, and BC = 1. E is the mid-point of BC, and F is a point such that EBAF is a square. On CF construct outward an equilateral $\triangle$CFG ($\angle$BCG = 105°). D is the mid-point of BA. Then DG = $\sqrt[3]{2}$ approximately.

Solution by Walter C. Eells, Whitman College, Walla Walla, Washington.

Draw a line through D $\parallel$ BC meeting FC in K and meeting the line from G $\perp$ BC in J. Then from the right triangles FEC and FKG, FC = FG $=1/2\sqrt{2}$, GK $= 1/4\sqrt{6}$, KJ = JG $= 1/4\sqrt{3}$. In the right triangle DJG, $DG^2 = DJ^2+JG^2 = (6+3\sqrt{3})/8+3/16 = 1.58701905$ approximately. Therefore DG = 1.25977 (approx.) But $\sqrt[3]{2} = 1.25992$ to five places.

The given approximation is correct to three places and differs by only a single unit in the fourth place, or it is an error by one part in 7,000, or one seventieth of 1 per cent.

Also solved by *Moe Buchman, Brooklyn Evening High School, E. Tabor,* and by *Michael Goldberg, Philadelphia,* who stated the relation as:

$$(DG)^2 = (1+a)^2+(a+1/4)^2 \text{ where } a = \sin 45° \sin 15°.$$

Like the problem on the trisection of an angle, this problem is famous historically, and was known as the Delian Problem from the legend that the Delians in order to be relieved of a plague were told by Apollo to double the volume of his altar which was in the form of a cube. The above approximate construction is remarkable for its accuracy. Does any reader have information about other approximate constructions for either this or similar problems?

703. *Proposed by L. E. Lunn, Heron Lake, Minnesota.*

A man bought a cow which each year for twenty years thereafter gave birth to a heifer calf. Each of the calves, at the end of two years gave birth to a heifer calf, and continued thereafter with all the descendants in this same ratio. How many head of cattle were there originating from the one cow at the end of twenty years?

Solution by E. Tabor, Upper Lake, California.

At the beginning there was 1 cow; at the end of the first year 2; at the end of the second year 3; end of third 5; end of fourth year 8; and the series representing the number at the end of each year is:

$$2, 3, 5, 8, 13, 21, 34, 55, 89, 144, \cdot \cdot \cdot \cdot \cdot$$

If we prefix the number 1 to the series, then at the end of the 20th year we will have the number given by the 21st term of this new series. The following relations hold for the terms in the series, T_n being the nth term (when 1 is the first term):

(1) $T_n = T_{n-1}+T_{n-2}$

(2) $T_{2n} = (T_n)^2+(T_{n-1})^2$

(3) $T_{2n-1} = (T_n)^2-(T_{n-2})^2$

Hence $T_{21} = T^2_{11}-T^2_9 = 144^2-55^2 = 17711$ and there were 17,710 head of cattle originating from the one cow.

Also solved by *Michael Goldberg.* It is easy to see that any term in the series will equal the sum of the two preceding, for the number of cows in any year is equal to the number in the preceding year plus the number born that year, which is the number in the second preceding year. But the derivations of relations (2) and (3) above are not shown. It is suggested as a further problem.

704. *Proposed by J. N. Warner, State Normal School, Platteville, Wis.*

Find integral values of x and k which will satisfy the equation $129x = 133k+3920$. This equation arises from the problem: A dealer bought

eggs at such prices that he averaged paying 19c for 7 eggs; 8 eggs were lost, and the remainder sold at an average of 70c for every 19 eggs. Find the number of eggs if k was the profit. Another similar problem is the following from *Glashan's Arithmetic:* A dealer bought some eggs at the rate of 11 for 9c, lost 3 eggs, and sold the rest at 9 for 11c, gaining \$2.63. Here the equation is $40x = 99k+363$. What other value besides $k = 263$ will give an integral value of x? More generally stated the problem is this: Is there any relation which can be used to make problems of the above types such as the relations, for example, that we have in making triangles with integral sides and satisfying certain other conditions?

Solution by Michael Goldberg, Philadelphia, Pennsylvania.

The indeterminate form is solved as follows:

$$\begin{array}{lll}
129x = 133k+3920 & & x = k+30+(4k+50)/129 \\
\text{Let } a = (4k+50)/129 & \text{which gives } k & = 32a-12+(a-2)/4 \\
\text{Let } b = (a-2)/4 & \text{which gives } a & = 4b+2
\end{array}$$

Retracing our steps we get

$$\begin{array}{ll}
k = 129b+52 & = 52, 181, 310, \cdots \\
x = 133b+84 & = 84, 217, 350, \cdots
\end{array}$$

In the same way

$$\begin{array}{lll}
40x = 99k+363 & & x = 2k+9+(19k+3)/40 \\
\text{Let } a = (19k+3)/40 & \text{which gives } k & = 2a+(2a-3)/19 \\
\text{Let } b = (2a-3)/19 & \text{which gives } a & = 9b+1+(b+1)/2 \\
\text{Let } c = (b+1)/2 & \text{which gives } b & = 2c-1
\end{array}$$

Retracing the steps, we get

$$\begin{array}{ll}
k = 40c-17 & = 23,\ 63,\ 103,\ 143, \cdots \\
x = 99c-33 & = 66,\ 165,\ 264,\ 363, \cdots
\end{array}$$

Also solved by *Norman Anning, Ann Arbor, Mich., Moe Buchman, F. A. Cadwell, Isidore Ginsberg, East Side High School, Newark, N. J., C. E. Githens, Wheeling, W. Va., J. L. Riley, Stephenville, Texas,* and *E. Tabor.* The answer to the proposer's concluding question is best answered in the remark by *I. Ginsberg:*

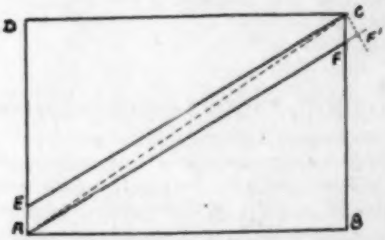
If we word the problem: A dealer bought eggs at such prices that he paid c cents for a eggs, lost e eggs, and sold the remainder at the rate of b cents for d eggs. Find the number of eggs, x, if k was the profit. Then the solution depends on the equation $(ab-cd)x = adk+abc$ and no matter how a, b, c, d, e are chosen we can find numbers k and x which will satisfy the equation.

The reader is also referred to an article on *Diophantine Analysis* in the May, 1921, issue of School Science and Mathematics by *M. O. Tripp.*

705. *For high school students. Proposed by the Editor.*

ABCD is a rectangular garden, AB = 60, and AD = 40. E is a point on AD, and F a point on CB such that AE = CF. The parallelogram AFCE is the walk, three feet wide, going through the garden. Find the area of the walk.

I. *Solution by Nevada Tabor, Sophomore, Upper Lake Union H. S., California.*



In the parallelogram AFCE, let $AE = x = CF$. Then $60x = 3AF$ since either member is the area of AFCE. But $AF^2 = 60^2+(40-x)^2$. Hence $399x^2+80x-5200 = 0$, or $x = 3.5112+$, and $60x$ or the area equals $210.672+$ sq. ft.

Similarly solved by *James V. Montgomery, Okmulgee High School, Oklahoma.*

II. *Solution by Irvin Knoebel, Belleville Township High School, Illinois.*

Draw AC, and a perpendicular CF′ to AF produced. $AC = \sqrt{5200}$; $CF' = 3$. $\sin \angle F'AC = CF'/AC$, or $\angle F'AC = 2°23'3.75''$

In $\triangle ABC$, $\tan \angle BAC = CB/AB$, or $\angle BAC = 33°41'24.5''$

Hence, $\angle BAF = 31°18'20.75''$, and $AF = AB/\cos \angle BAF = 70.225$

Then the area of the walk is $AF \times CF' = 210.675$.

Similarly solved by *Moe Buchman*, by the *Senior Class in Trigonometry, Okmulgee High School, Oklahoma*, and by the *Junior Class, Redlands High School, California.*

PROBLEMS FOR SOLUTION.

716. *Suggested by E. Tabor's solution of problem 703.*

For the series 1, 2, 3, 5, 8, 13, 21, 34, · · · · ·
in which $T_n = T_{n-1} + T_{n-2}$ prove:

$$T_{2n} = (T_n)^2 + (T_{n-1})^2 \text{ and } T_{2n-1} = (T_n)^2 - (T_{n-2})^2$$

717. *Proposed by Daniel Kreth, Wellman, Iowa.*

Construct the triangle, given $\angle A$, the length d of the bisector of this angle, and the sum e of the including sides AB and AC.

718. *Proposed by F. Howard, San Antonio, Texas.*

A clock has three hands, the hour, minute and the second, on the same pivot. What is the first time after 12 o'clock when the hands will be equally distant?

719. The following problem was proposed for the high school students in the June issue. Since it is perhaps too complicated for undergraduates, we propose it here again:

A, B, C are three buoys, $AB = 320$, $BC = 435$, $CA = 600$. A ship, at S, finds that AB subtends an angle of 8° and BC an angle of 26°. How far is the ship from each of the buoys?

720. *For high school students. Proposed by the Editor.*

A can do a certain piece of work in 25 days, B in 22, C in 20 days. A starts on the job and after working 3 days, hires B to assist him; then three days later C also begins working. How soon is the job completed?

The department has received from John Lundberg some very interesting examination questions from the schools of Göteborg, Sweden, which will be shown here next month.

HIGHEST PLACE IN RHODE ISLAND.

The highest point in Rhode Island is Durfee Hill, in Providence County, which is 805 feet above sea level, according to the United States Geological Survey, Department of the Interior. The average elevation of the state is approximately 200 feet.

CALIFORNIA'S LOFTY MOUNTAINS.

At least sixty mountains in California rise more than 13,000 feet above sea level, but they stand amid a wealth of mountain scenery so rich and varied that they are not considered sufficiently noteworthy to be named, according to the United States Geological Survey, Department of the Interior. Yet if any one of these unnamed mountain peaks were in the eastern part of the United States it would be visited annually by thousands of people. But California has seventy additional mountain peaks more than 13,000 feet high that have been named, or 130 in all, as well as a dozen that rise above 14,000 feet.

CONTINUATION SCHOOLS: SHOULD THE TEACHING BE CONSIDERED OF ELEMENTARY OR SECONDARY SCHOOL GRADE?

By JOHN CROWELL,
Head of South Division Continuation School, Chicag.

The problem of continuation schools is one of the most vital, educationally, that America faces to-day. Much has been achieved in the development of elementary schools, much too, especially in the past twenty-five years, along the line of secondary schools. Our colleges and universities compare favorably with those of other countries; but in vocational training we lag. Our part-time schools are in their infancy. In Chicago I think it fair to say, we are abreast of the times, but there is still much to do. Here we have annually several thousand children leaving school at fourteen years of age to enter industry, with, in large numbers of cases, only the barest rudiments of a general education, and with no trade training whatsoever. In a surprising number of cases, they have the further handicap of a foreign language spoken at home, and, in many cases, studied at school.

All educators must recognize that the problems of childhood, between the ages of seven and fourteen, are those peculiar to the elementary school. Here, intellectual training is the important thing, and the foundation for all later training of whatever nature. With the coming of adolescence, the nature of the children and the method of handling them are radically changed. No need to describe adolescence to an audience like this. Emphasis shifts from purely intellectual training, or training very largely intellectual, to teachers which recognizes the development of emotional life at this stage; training for citizenship is the watch word; responsibility must be developed, will power strengthened, the social and moral qualities brought to maturity. George Kirschensteiner, Director of the Public Schools of Munich, makes the point that, "While a broad, general education is the most praiseworthy end of all education to attain an independent view of the universe, yet it is attainable by but few mortals. Heteronymous development of a firm will, directed to good purposes by means of discipline and habit, is for the overwhelming majority of men safer and quicker to arrive at than the development of a steady view of the world, which influences character automatically. Intelligence influences the will, but does not make the will."

Now I submit to you that the children, who have most successfully survived the eight years of training in the elementary schools, go on to high school, either the general or the technical. Of these the former carries on the intellectual training successfully started in the elementary school; it also, being manned—and "womaned"—by highly trained, cultured and successful teachers—teachers who have made a special study of adolescent problems—carries on in a collateral way, training in development of civic responsibility, will power, and moral qualities generally. The technical high school also carries on in much the same way, only here the technical training is especially emphasized; the general aims are the same as in the general high school, the means different. Here, too, may be the added objective of preparing children for more advanced technical training in the University or engineering schools, just as the general high school may have the objective of preparing them for general college courses.

Perhaps I should mention at this point, the prevocational schools, whose problems are largely the same as those of the continuation schools.

Discussed at a meeting of Chicago continuation school teachers, June 20, 1921.

Children of adolescent age, who have become retarded, are taken out of their regular classes in the elementary schools and placed in special classes in high schools, with the idea that a little more technical work than is advisable in elementary schools might constitute a stronger appeal than academic studies have done. These are people to whom the traditional curriculum of the elementary schools has not appealed. Let me ask if anybody ever argued that, since these children have not completed the standard course at the standard age, they should be shunted back and given a little more of the same? No sensible person could defend such a policy. Let us see if the continuation school children may not be the same as the others I have been discussing.

It is maintained by certain people in authority, that quite the proper way to handle continuation school children is to have elementary teachers do the work. I take it such people might argue that the subject matter is largely that of the elementary schools, that elementary school teachers have a grasp of the needs of such children, and will work for roughly half to two-thirds the pay the high school teachers receive. I don't know whether the advocates of this plan would make it cover all continuation school people, sixteen to eighteen as well as fourteen to sixteen; we know that the time will soon be upon us when we must care for these older boys and girls. Passing that point, we find that a considerable percentage of our boys and girls have had eighth grade training, about forty per cent, I suspect. An investigation at the South Division School last winter showed forty-three per cent.

The rest, i. e., those who did not finish the grammar school course, are in much the same class, I think, as the prevocational children. I fear any plan that contemplated forcing them back on the same pabulum. They, in many cases, left school to avoid foredoomed failure. They are no longer elementary school children, physically or mentally, and what experience has shown is proper in the way of subject matter and teaching methods for elementary schools will not do for this kind of a school. The proof is in the very fact that those methods and that subject matter have failed to hold the children. It would surely fail if tried again.

At a recent meeting of Chicago Continuation School Teachers, Mr. Campbell, Chief Examiner of the Chicago Board of Education, declared that the continuation schools should have the best teachers available anywhere, inasmuch as the pupils in these schools are in general the least fortunate of our fourteen to sixteen year old boys and girls. It seems as if this statement would be accepted without question by all educators. Wherever in these part time schools those in charge have had the courage to put aside old methods and traditions and blaze new trails, success has generally followed. Chicago is no exception. One innovation was the plan of considering our work of strictly high school grade, irrespective of what grade our children had reached in school, since they were of high school age. I think it is fair to say that whatever success we have had in Chicago is due to the recognition of the fact that adolescence demands different methods, different subject matter, and a different kind of teacher.

So much for those who have not finished the traditional course of study for the first eight grades. As for the forty per cent, roughly, who have finished the eight grades, it seems self-evident that nothing but high school grade of teaching will do for them. In all fairness, since their time in the schools per week is so short in comparison to high school children, they should have not only high school teaching but the very best kind of high school teaching. Who can argue anything to the contrary?

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Now shall we attempt to separate these two classes? The evidence of intelligence tests given children in our part time schools is clearly against this plan. Those children who have left the elementary schools before graduation frequently come out better in these tests than the graduates. It may be said further that with two normal children, one leaving school at the seventh grade, another of the same age leaving school at the eighth grade, the first spending that year in an occupation which calls for a certain amount of application in mathematics and English for example, no real difference can be discovered after a year or two between these two in purely academic attainment.

If it seems best to separate those which are to receive a higher grade of teaching from those who are to receive a lower, let this separation by all means be made by intelligence tests and not be determined by the grade reached in school. The question then would naturally arise, would the better grade of teaching be given the higher grade of students or the lower? Sound pedagogy would say the lower by all odds. Thus our whole question becomes a reductio ad absurdum. No intelligent community would stand for any plan which would involve a caste system; any scheme to separate the better students from the poorer would certainly imply such a system. In addition it would be fatal for the poorest students to be deprived of the contact with their superiors. All in all the experience in Chicago part time schools is all in favor of a unified scheme, where the plan is to give two years to laying the foundation, treating all children alike, and two years, sixteen to eighteen, for filling out the course and giving trade extension work.

Whatever the relative merits of men and women teachers may be, I think all educators would agree that boys of the adolescent age need men teachers. The Chicago Continuation Schools have an excellent corps of men and women, the men I believe being slightly in the majority. To reduce the work to the grade school level would certainly result in driving most, perhaps all of our men back to the high schools.

The only point possible in favor of abandoning a standard once established and substituting a lower is the theoretical saving in money. If we admit that the pupils from sixteen to eighteen years of age and those from fourteen to sixteen who have finished the grammar school course should have high school teachers, there remains less than thirty per cent in all probability who be affected. Apparently half of the expense of educating this thirty per cent would be saved, since grade school teaching costs only about half of what high school does. That the continuation schools, however, are not expensive to maintain, even with teachers of full high school grade, by comparison with full time schools, is shown by the per capita cost of the teaching in Chicago:

High school	$103.03
Elementary	47.85
Continuation school (reduced to ten months' basis)	39.90

It seems clear, in view of the facts and figures pointed out above and in view of the problems which confront the continuation schools only, that what is needed is practical people from the trades with a high degree of training and with a breadth of character and culture to insure good technical instruction; in addition highly cultured instructors with imagination, vision, adaptibility, etc., to teach work related to the trades. Let me cite in support of this statement the fact that we have no texts. The teaching is done by means of job sheets, which means "write your own text." Teachers handling related work must be familiar with trade matters. Proper civic instruction (and civics is considered of the highest importance in these schools) demands the greatest breadth of culture.

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be had for 30 cents a single copy. The Mathematical Supplements for 15 cents a copy.

In sets the prices are, postpaid:

School Mathematics and Supplements, Vol. I, five numbers	$1.00
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School Science and Mathematics, Vols. XVIII, XIX and XX each	2.50

In conclusion, let me say we may perhaps have made mistakes in Chicago part-time schools—mistakes of inexperience—but on the whole, we have proved adaptable and come through with at least a fair record. Would grammar school teachers have done better or worse? Would they have proved more or less adaptable? Would they have risen above the limitations of text books and exact supervision and blazed a new trail? Kirschensteiner says, "*Wherever the training is confined to the mere extension of what is taught in the elementary schools, it has proved to be a failure. Schools have no attraction whatever.*"

What educator now is willing to go on record as favoring a standard once established, and the inauguration of one only half as good? Kirschensteiner uses the phrase, "broadening the bases of our educational system." Shall we have to change this to "narrowing"?

The films (two, 1,000 feet each) on geometry, which Charles H. Sampson, Huntington School, Boston, has been working on for the past year are now completed and ready for distribution. These are being distributed by the Society for Visual Education, 806 West Washington Boulevard, Chicago, Ill.

These films are standard width.

HIGHEST POINT IN CONNECTICUT.

Although Connecticut is very nearly our smallest state, only Rhode Island and Delaware containing fewer square miles, its altitude ranges from sea level to more than two thousand feet above sea level, according to the United States Geological Survey, Department of the Interior. The highest point, Bear Mountain, in Litchfield County, is 2,355 feet above the sea. The average elevation of the state is approximately 500 feet.

THE RED CROSS AND THE COLLEGES.

College men and women should feel it peculiarly their duty to support the American Red Cross in its forthcoming annual roll call, to be held November 11-24. For the Red Cross, from the beginning, has been supported and directed very largely by college men, because its aims and ideals are the aims and ideals which the training received in universities and colleges has taught them to honor and cherish, because it is constructive, and gives them the opportunity of applying those ideals practically.

The Red Cross needs support this year more than ever before. The war-time work was dramatic, picturesque; the peace-time work, although just as indispensable, cannot arouse so intense a public interest. Work for the disabled soldiers, for the dependent children in Eastern and Central Europe, Disaster Relief preparedness, First Aid instruction, Public Health Nursing—these are not things in which the average man, untouched himselif by misfortune, can find a thrilling interest.

Yet that all these activities are relieving an incalculable amount of sufferng no one can deny. A thousand disabled ex-service men are reporting every month at hospitals for treatment, and last year the Red Cross spent $10,000,000 in helping these disabled men alone. And that was $4,000,000 more than the aggregate receipts from the year's membership dues. Obviously if the work is to continue, popular support must be greatly strengthened. It remains for the college men and women of the country, undergraduates and alumni, to work together to see that these things are not allowed to fail.

THE NATIONAL COMMITTEE IN MATHEMATICAL REQUIREMENTS.

The National Committee on Mathematical Requirements on September 5 held its last meeting under its present form of organization. One phase of its work has come to an end. The manuscript of a summary of the final report of the committee has been sent to the U. S. Bureau of Education for publication. This summary, which will constitute a bulletin of some eighty pages, virtually presents the first part of the complete report. It contains the following chapters:

I. A Brief Survey of the Report.
II. Aims of Mathematical Instruction—General Principles.
III. Mathematics for Years Seven, Eight, and Nine.
IV. Mathematics for Years Ten, Eleven, and Twelve.
V. College Entrance Requirements in Mathematics.
VI. List of Propositions in Plane and solid Geometry.
VII. The Function Concept in Elementary Mathematics.
VIII. Terms and Symbols in Elementary Mathematics.

It also contains a brief synopsis of the remaining chapters of the complete report. It is expected that this summary will appear late in November or early in December.

It was the original intention of the committee to publish its complete report also through the U. S. Bureau of Education. It was found, however, that this would involve a delay of two or three years in view of the fact that it would have been necessary for the Bureau of Education to issue the report in parts extending over a considerable period of time. It is hoped at present that sufficient funds will be obtainable to print the report during the winter and to distribute it free of charge to all who are sufficiently interested to ask for it. The complete report will constitute a volume of about five hundred pages. In addition to the chapters listed in the summary, it will contain an account of a number of investigations instituted by the committee. Among these may be mentioned: The Present Status of Disciplinary Values in Education; A Critical Study of the Correlation Method Applied to Grades; Mathematical Curricula in Foreign Countries; Mathematics in Experimental Schools; The Use of Mental Tests in the Teaching of Mathematics; The Training of Teachers of Mathematics. There will also be included an extensive bibliography on the teaching of mathematics.

In closing this phase of its work, the committee desires to extend its most cordial thanks to all the individuals and organizations that have helped. The response secured by the committee to its appeal for assistance in solving the many problems facing it has been extremely enthusiastic and gratifying. This leads the committee to look forward to the future optimistically. The real work for which the committee was appointed may be said to begin with the publication of its report rather than to end with it. Continued enthusiastic activity on the part of all individuals and organizations concerned with the teaching of mathematics is needed over a period of many years to put the recommendations of the committee into effect to test their validity and to modify them in ways that experience shows to be desirable. In order to be of assistance in this direction, the committee hopes to be able to maintain an office with a certain amount of clerical help during the next few years so that it may continue to act as a clearing house for ideas and to stimulate the discussion of problems relating to the teaching of mathematics among the nearly one hundred organizations that have in the past been actively cooperating with the committee.

The recommendations of the National Committee have been made the

object of class room presentation and discussion at a large number of summer schools throughout the country this summer. Indeed some of the most prominent institutions have built the work in mathematics intended for the preparation of teachers around the various preliminary reports of the National Committee.

Professor E. R. Hedrick, of the University of Missouri, lectured before a number of institutions on behalf of the National Committee from June 20 to August 9. The institutions visited were: The University of Texas; The University of Oklahoma; The University of Nebraska; The State Normal Schools at Peru and Kearney, Nebraska; The University of Chicago; The University of Iowa; Iowa State Teachers College; The University of Michigan; Northwestern University. Professor Hedrick was enthusiastically received at all of these institutions.

ARE COLLEGE GRADUATES IN CHEMISTRY FITTED TO TAKE UP RESEARCH PROBLEMS? IF NOT, WHY NOT?

By H. D. Gibbs.

My experience in Universities, in Government and in Industrial Research Laboratories leads me to answer the first question in the negative. A graduate of a four-year course, as ordinarily arranged for specialization in chemistry, is seldom fitted for research, and a Doctor of Philosophy with seven years of University study behind him, is often woefully lacking.

This deficiency, in my opinion, may be attributed to several causes.

I would put first, the small percentage of graduates who have the making in their fibre of real research men. For the past few years chemistry has been the most advertised of the sciences and therefore on account of the great war activities and the salaries that industries offered to pay, not only to the best but also to men of mediocre ability, many have flocked to the University lecture rooms and laboratories when it would have been more advantageous both to themselves and to the advancement of chemistry had they chosen another profession or training for their life work. We are now facing an over production of so-called chemists. I do not believe this country will be saturated in the near future with an adequate number of real chemists, but the difficulty at the present is the winnowing of the wheat from the chaff. To a certain extent both are suffering, due to that portion of the cycle, both business and educational, in which we are now operating.

We have always in course of production in educational institutions and even in research laboratories attached to industries, a small percentage of men who will be research chemists of the highest grade, not primarily due to the surrounding conditions, but in spite of them, given the proper environment in educational facilities, inspiration both from teachers, directors and associates, this number is greatly increased.

A second cause may be placed as lack of proper educational facilities and inspiration. By proper educational facilities I do not refer so much to well equipped laboratories and lecture rooms, that is the plant, as I do the the courses of study and the methods of presenting them.

The best research men do not have their minds crowded with facts, figures and reactions, but they do have fundamental principles and methods of working and have acquired skill in handling apparatus, manipulations and careful and complete observations. A general knowledge of the literature has been acquired so that complete data of any specific subject can be found with facility.

Without the proper inspiration from superiors, associates and surroundings good research is almost impossible. For these reasons many of our industrial laboratories are, at the present time, poor places to develop and foster research.

ARTICLES IN CURRENT PERIODICALS.

American Botonist, for August, *Joliet, Illinois; $1.50 per year, 40 cents a copy.* "The Victoria Water Lily," Willard N. Clote; "Plant Names and Their Meanings," Willard N. Clote; "Fossil Plants and Classifications," Henry S. Conrad; "Midsummer Flora of Zuba Oasis."

American Forestry, for September; *Washington, D. C.; $4.00 per year, 40 cents a copy:* "The Present and Prospective in Forestry," Filibert Roth, with three illustrations; "The Pines of the South," J. S. Illick, with sixteen illustrations; "The Bandelier National Monument," Will C. Barnes, with seventeen illustrations; "Home Building and Wood Preservatives," Arthur N. Pack, with nine illustrations; "Common American Mushrooms," Dr. R. W. Shufeldt, with thirteen illustrations; "Perennials," F. L. Mulford, with four illustrations.

American Journal of Botany, for July; *Brookly Botanic Garden; $6.00 per year, 75 cents a copy:* "The Relation of Crop-plant Botany to Human Welfare," Carlton R. Ball; "Correlations Between Anatomical Characters in the Seedling of Phaseolus Vulgaris," J. Arthur Harris, Edmund W. Sinnott, John Y. Pennypacker, and G. B. Durham; "A Quantitative Study of the Effect of Anions on the Permeability of Plant Cells—II, Oran L. Raber; "The Mechanism of Root Pressure and Its Relation to Sap Flow," James Bertram Overton.

American Mathematical Monthly, for June-July; *Lancaster, Pa.; $4.00 per year, 45 cents a copy:* "Rational Triangles and Quadrilaterals," Professor L. E. Dickson; "The Triangle of Reference in Elementary Geometry," Professor Lennie P. Copeland; "Among My Autographs;" 8. "Francoeur Describes a King;" 9. "LeVerrier and the Cost of Living," Professor D. E. Smith; "The Formula $\frac{1}{2}a(a+1)$ for the Area of an Equilateral Triangle," Professor G. A. Miller; "Note on the Prime Divisors of the Numerators of Bernoulli's Numbers," Professor E. T. Bell; "Questions and Discussions: Questions—43, 44. Discussions—"The intersection of two conic sections with a common focus," Dr. H. F. Mac Neish; "An Arithmetical Perpetual Calendar," Dr. Philip Franklin.

Condor, for July-August; *Eagle Rock, California; $2.00 per year, 40 cents a copy:* "The Storage of Acorns by the California Woodpecker" (with one photo), Henry W. Henshaw; "The Storage of Almonds by the California Woodpecker" (with one photo), Claude Gignoux; "The Flock Behavior of the Coast Bush-Tit" (with map), R. C. Miller; "Genera and Species," Richard C. McGregor; "A Synopsis of California's Fossil Birds," Loye Miller.

Photo-Era, for August; *Boston, Mass.; $2.50 per year, 25 cents a copy:* "A Pilgrimage to Wolfeboro, New Hampshire," Turner and Osborne; "Base-Ball Photography," Leonard C. Lee, Jr.; "Livelihood or Pastime?" W. P. Mattern; "My First Photograph," Rudolf Eickemeyer; "True Education," Edward Shaunessy; "Hobbies," Sigismund Blumann; "Speed-Limits," British Journal.

School Review, for September; *The University of Chicago Press; $2.50 per year, 30 cents a copy:* "Educational News and Editorial Comment;" "The Junior High Schools of Montclair, New Jersey," R. L. Lyman; "Keeping the Score," Arthur L. Campbell; "Current Conceptions of the Special Purposes of the Junior College," Leonard V. Koos; "An Experiment in Pupil Self-Government," Frank W. Stahl; "The Declining Importance of State Funds in Public-School Finance," Fletcher H. Swift.

Scientific Monthly, for September; *Garrison, N. Y.; $5.00 per year, 50 cents a copy:* "The Biology of Death—Natural Death, Public Health and the Population Problem," Raymond Pearl; "Impending Problems of Eugenics," Irving Fisher; "A Few Questionable Points in the History of Mathematics," G. A. Miller; "The Earliest Printed Illustrations of Natural History," William A. Locy; "Getting Married on First Mesa, Arizona," Dr. Elsie C. Parsons; "Harmonizing Hormones," B. W. Kunkel; "Grazing Practice on the National Forests and its Effect on Natural Conditions," Clarence F. Korstian.

BOOKS RECEIVED.

Food Products, Their Source, Chemistry and Use, by E. H. S. Bailey, University of Kansas. Second edition. Pages XVI+551. 14×20 cm. Cloth. 1921. $2.50 net. P. Blakiston's Son & Co., Philadelphia

The Practice of Lubrication, by T. C. Thomsen, Chief Engineer to the Vacuum Oil Company, London. Pages XI+607. 15.5×23.5 cm. Cloth. 1920. McGraw-Hill Book Co., New York City.

The Elements of High School Mathematics, by John B. Hamilton, the University of Tennessee, and Herbert E. Buchanan, edited by George W. Myers, the University of Chicago. 297 pages. 12×18 cm. Cloth. 1921. Scott, Foresman and Co., Chicago.

Elementary Qualitative Analysis of the Metals and Acid Radicals, a Laboratory Manual, by Frederick C. Reeve, East Side High School, Newark, N. J. Pages VII+141. 13.5×20 cm. Cloth. 1921. D. Van Nostrand Company, New York City.

Plane Trigonometry, by Arnold Dresden, University of Wisconsin. Pages VII+110. 14.5×22 cm. Cloth. 1921. John Wiley and Sons, New York.

An Introduction to Mathematical Analysis, by Frank L. Griffin, Reed College, Portland, Ore. Pages VIII+512. 13.5×19.5 cm. Cloth. 1921. $2.75. Houghton Mifflin Company, New York.

Elementary Principles of Chemistry, by Raymond B. Brownslee, Robert W. Fuller, Stuyvesant High School, William J. Hancock, Erasmus Hall High School, Michael D. Sohers, Morris High School, and Jessie E. Whitsit, DeWitt Clinton High School all of New York City. Pages IX+588+17. 13.5×19.5 cm. Cloth. 1921. Allyn and Bacon, Chicago.

Training for the Public Profession of the Law, by Alfred Zantzniger Reed. Bulletin No. 15. Pages XVIII+498. 15.5×23.5 cm. Paper. 1921. The Carnegie Foundation for the Advancement of Teaching, New York.

Analytic Geometry, with introductory chapter on the Calculus, by Claude I. Palmer and William C. Krathwohl, both of the Armour Institute of Technology. Pages XIV+347. 13×19 cm. Cloth. 1921. McGraw-Hill Book Company, New York City.

Civic Science in the Home, by George W. Hunter, Knox College, and Walter G. Whitman, State Normal School, Salem, Mass. 416 pages. 13.5×19 cm. Cloth. 1921. $1.40 American Book Company, Chicago.

Essentials of Physics, by George O. Hoadley, Swarthmore College. Revised edition. 544 pages. 13.5×18.5 cm. Cloth. 1921. American Book Company, Chicago.

American Men of Science, a Biographical Directory, by J. McKeen Cottell and Dean R. Birnshall, Garrison, N. Y. Pages VIII+808. 19.5×26 cm. Cloth. 1921. $6. The Science Press, Garrison, N. Y.

Statistics of Universities, Colleges, and Professional Schools, 1917-18, Bulletin, 1920, No. 34, by H. R. Borner. 222 pages. Paper. Government Printing Office, Washington.

The New World; Problems in Political Geography, by Isaiah Bowman, Director of the American Geographical Society, with 215 maps and 65 half-tones. Pages VII+632. 17×25 cm. Cloth. 1921. World Book Company, Yonkers-on-Hudson, N. Y.

State Laws Relating to Education enacted in 1918 and 1919, Bulletin, 1920, No. 30, by William R. Hood. 231 pages. 14.5×23 cm. Paper. Washington, Government Printing Office.

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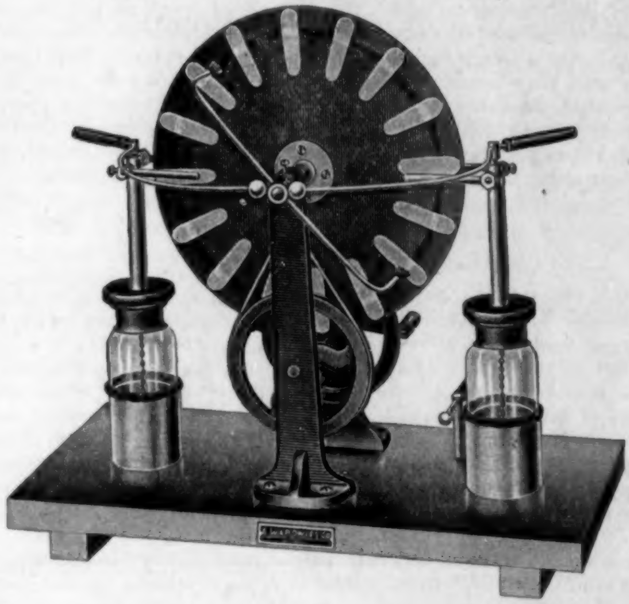

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BOOK REVIEWS.

The New World Problems in Political Geography, by Isaac Bowman, Director of the American Geographical Society. Illustrated by 215 maps and 65 half tones. 632 pages. 16½×24½ cm. Cloth. 1921. $6.00. The World Book Company, Yonkers-on-Hudson, N. Y.

This is indeed a most wonderful book. It consists of an immense amount of information which has required the author several years to secure. It has been gathered and collated and put up in such shape that the reader cannot help but be impressed with the accuracy and authority with which the author writes. Even though one is not directly interested in the work he cannot help but be interested in reading this admirable text.

The maps are as near accurate as it is possible, in this changing period of our world, to make them. The data as expressed by the maps and charts is splendidly done and one is able at a glance to get information which otherwise would require several hours of study.

The work covers matter appertaining practically to the entire world. It should be in the hands of everyone interested in human geography.

C. H. S.

Civic Science in the Home, by George W. Hunter, Knox College, Galesburg, Ill. and Walter G. Whitman, State Normal School, Salem, Massachusetts. Pages 13×18½ cm. Cloth. 1921. $1.40. American Book Company, Chicago.

One of the most progressive and up-to-date texts in Civic Science which has come to the desk of the writer is the one named above. They surely have studied the psychology of the pupil in presenting this admirable book. It is written in a style that will attract the pupil and hold his attention.

Scattered throughout the book are innumerable half tones and drawings illustrating the matter in the text which had just been discussed. Most of these drawings and half tones were made especially for this work. Major paragraphs begin in bold face type in a short sentence which gives a key to the matter discussed in that paragraph.

The authors have done their best in giving each science its due propotion of matter. At the end of each chapter is a score card for the pupil's use; also a list of reference books bearing upon the matter touched in that chapter. The book is divided into seven parts and altogether there are twenty-five chapters. The book is splendidly indexed. Schools contemplating the introduction of Civic Science into their curriculum should first thoroughly study this book. C. H. S.

We have recently received from the W. M. Welch Scientific Company a very interesting little hand book descriptive of their form of the Hartel Optical Disk.

It is surely a very interesting little pamphlet consisting of twelve pages. There are some fifty odd cuts of the experiments that may be performed with this very useful piece of apparatus. All of the cuts are very nicely explained in the body of the work.

It will be well for every person interested in this work to send for this pamphlet. C. H. S.

Business Mathematics, by E. I. Edgerton, B. S., Instructor of Mathematics in the Wm. L. Dickinson High School, Jersey City, N. J., and W. E. Bartholomew, State Specialist in Commercial Education, New York State Board of Regents. 13×20 cm. Pages vi+305. 1921. The Ronald Press Company, New York.

The applied business mathematics as presented in this book gives pupils of the third and fourth high school years an advanced and thorough preparation for their future work either as employer or employee. In addition to the usual topics of commercial arithmetic there are the topics: Profits based on sales; pay-roll calculations; depreciation; graphical representation (38 pages); commercial applications of logarithms; the slide rule; and practical measurements. This book is not only an excellent text for class room use but also a practical reference manual for those engaged in business. H. E. C.

The Elements of High School Mathematics, by John B. Hamilton, The University of Tennessee and Herbert E. Buchanan, Tulane University. Edited by George W. Myers, The University of Chicago. 12×18 cm. Pages 297. 1921. Scott, Foresman and Company, Chicago.

A year's work in the elements of high school mathematics is provided in this book, and the subjects, arithmetic, algebra, and practical geometry are treated in separate units. Arithmetic has 51 pages, mensuration 19 pages, and algebra 212 pages. The aim is to give a review of fractions, percentage, and interest, to make the transition from arithmetic to algebra intelligible, facile, and revealing of deepened quantitive insight, and to train the hand and eye of the pupil through the use of the simpler drawing instruments. H. E. C.

Junior High School Mathematics, Book One, by Walter W. Hart, Assistant Professor of Mathematics, University of Wisconsin, School of Education. 12×18. Pages ix+226. 1921. D. C. Heath and Company Boston.

This book, the first of a series presenting a reorganized course in mathematics, is designed for the seventh grade or the lowest year of the junior high school. As one would expect from the preceding work of the author, this course is thorough going and practical, in that the selection and arrangement of material provides a review of the fundamental operations; makes a new appeal to gain the pupils' interest by introducing the beginnings of literal arithmetic and inductive geometry; and prepares for later courses by teaching correct ideas and mathematical habits and developing the desire and ability to understand the "why" of mathematical operations. Nearly one half of the book is given to inductive geometry, which is exceedingly well planned. A combination protractor is furnished with the text. Teachers in the junior high school should certainly examine this book. H. E. C.

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Fig. 1.

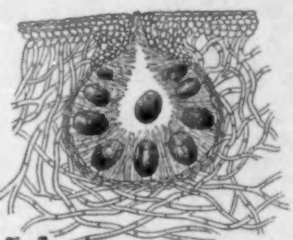

Fig. 2

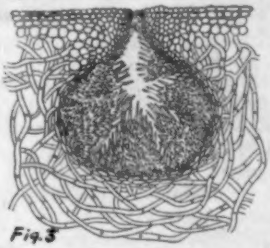

Fig. 3

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DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March and November issues of this Journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. This is extremely valuable information to all progressive teachers. Is your Society listed here? Names are dropped when they become one year old.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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Bureau, Washington, D. C.; *Secretary*, Charles F. Brooks, U. S. Weather Bureau, Washington, D. C.; *Treasurer*, Robert E. Horton, R. D. No. 1, Voorheesville, N. Y.—1220.

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(Annual meeting, November 24, 25, and 26, at the Soldon High School, St. Louis, Mo.)

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